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CATHEDRAL BLUFFS SHALE OIL COMPANY

OSPO PRESENTATION

RDDP ISSUES

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CATHEDRAL BLUFFS SHALE OIL COMPANY

OSPO PRESENTATION

RDDP ISSUES

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Aug. 1984

CATHEDRAL BLUFFS SHALE OIL COMPANY

CURRENT STATUS OF THE PROJECT

- PROJECT PLAN
- SFC -
- RDDP -
- PERMITS -

DDP ISSUES

- CONFIDENTIAL INFORMATION - UNION, OXY
- OIL RECOVERY AND LONG RANGE PLANS
- AGR

    - AGR PROCESSING, ORE FEED GRADE AND MINERALOGY
    - FINES
    - SPENT SHALE HANDLING AND DISPOSAL

- MIS

    - PROCESSING - MINERALOGY; DESIGN BASIS; START UP; STEADY STATE; QUENCHING
    - POST OPERATIONS PLAN -
        - DATA ANALYSIS/MODELING
        - PRE-IGNITION WATER MANAGEMENT
        - TESTING AND MONITORING
        - ABANDONMENT/RECLAMATION

- SUMMARY OF ISSUES

AUG. 1984

CATHEDRAL BLUFFS SHALE OIL COMPANY
Data Sheet - Initial Project Plan

MODIFIED INSITU DEVELOPMENT MINING

Production Units
(C/D) calendar day

- OXY MIS Technology
- Retort Development
  - 165 ft x 165 ft x 278 ft H

Production:

5 Retorts Developed Per Year		
Oil Shale (MIS Development)	27 GPT	2,109 Tons

MIS PROCESSING FACILITIES

Operations:

4 Retorts Processing Continuously
5 Retorts Processed per Year

Production:

OffGas	7471 MM BTU/D calendar day =	1,165 Bbls
Raw Shale Oil		2,260 Bbls
NH_3		46 Tons
$CA\ SO_4$		250 Tons

ROOM AND PILLAR AND GENERAL MINE - 40′ Mining Interval

Production:	39-45 GPT	10,690 Tons

ABOVE GROUND RETORTING AND MATERIALS HANDLING

Union B Retort Technology

Retort Feed Rate:	Up to 40 GPT	11,775 Tons

Production:

Raw Shale Oil	11,950 Bbls
Raw Shale Fines	1,024 Tons
Spent Shale	9,420 Tons
Sulfur Production (AGR)	20 Tons

OIL UPGRADING FACILITIES (OUG)

Union Oil Hydrotreating Technology

Feed: Raw Shale Oil	13,260 Bbls

Production:

High Quality Syn Crude Oil	14,100 Bbls
Sulfur (OUG)	22 Tons

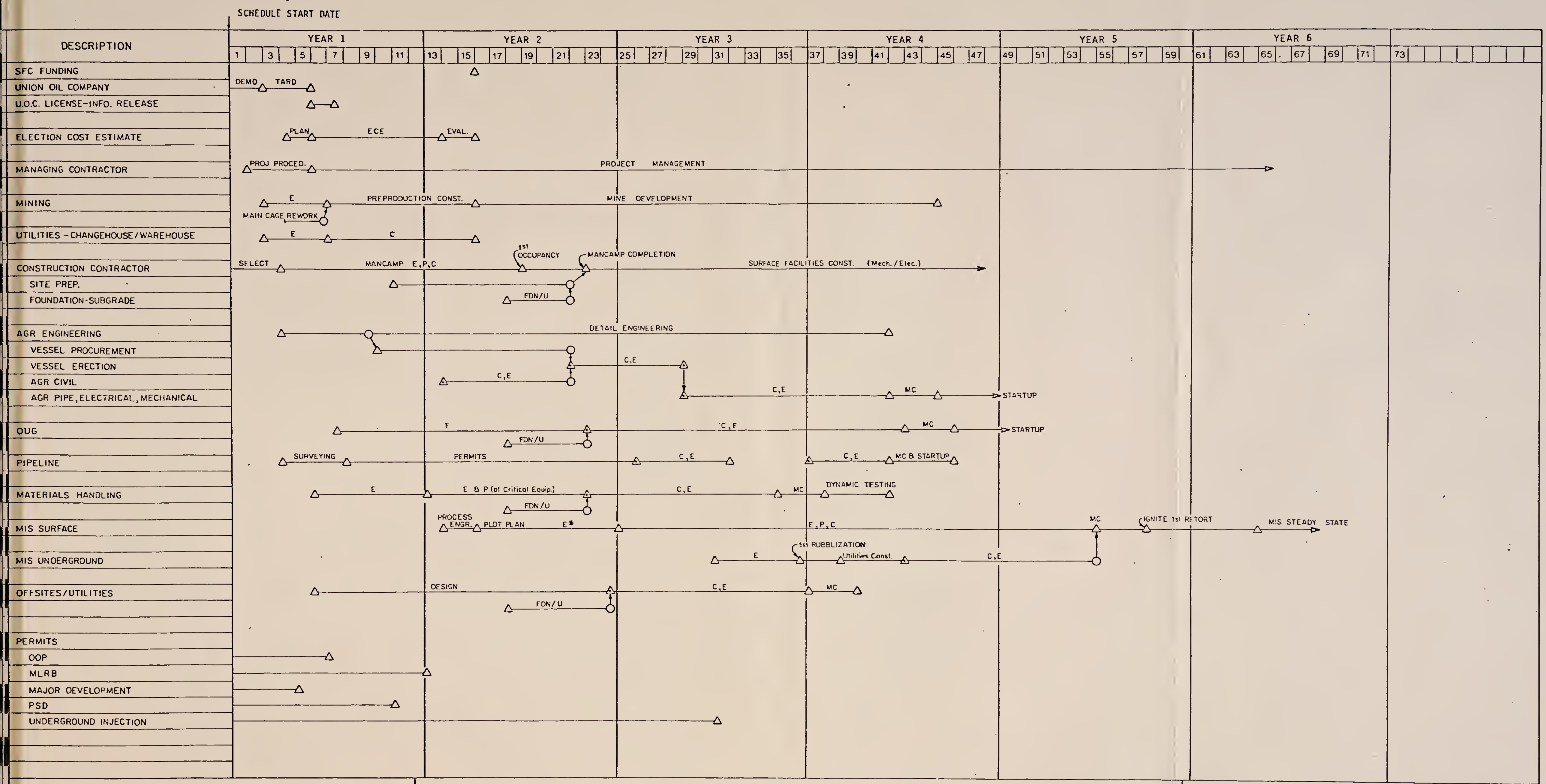
UTILITIES

Water Handling, Cooling, Treatment; Tankage

SYNCRUDE PIPELINE

8″ Line to Rangely Terminal

RET/pmr 8/10/84



Cathedral Bluffs Shale Oil Company

*PRODUCTION ENGR. STARTS MONTH 18
PRODUCTION ENGR. STARTS MONTH 14

LEGEND

E	ENGINEERING	△	ACTIVITY MILESTONE
P	PROCUREMENT	△	CONSTRUCTION ACTIVITY STARTS & ENGINEERING CONTINUES.
C	CONSTRUCTION	○	OUTPUT TO ANOTHER ACTIVITY.
MC	MECHANICAL COMPLETION		
FDN/U	FOUNDATIONS & UNDERGROUNDS		

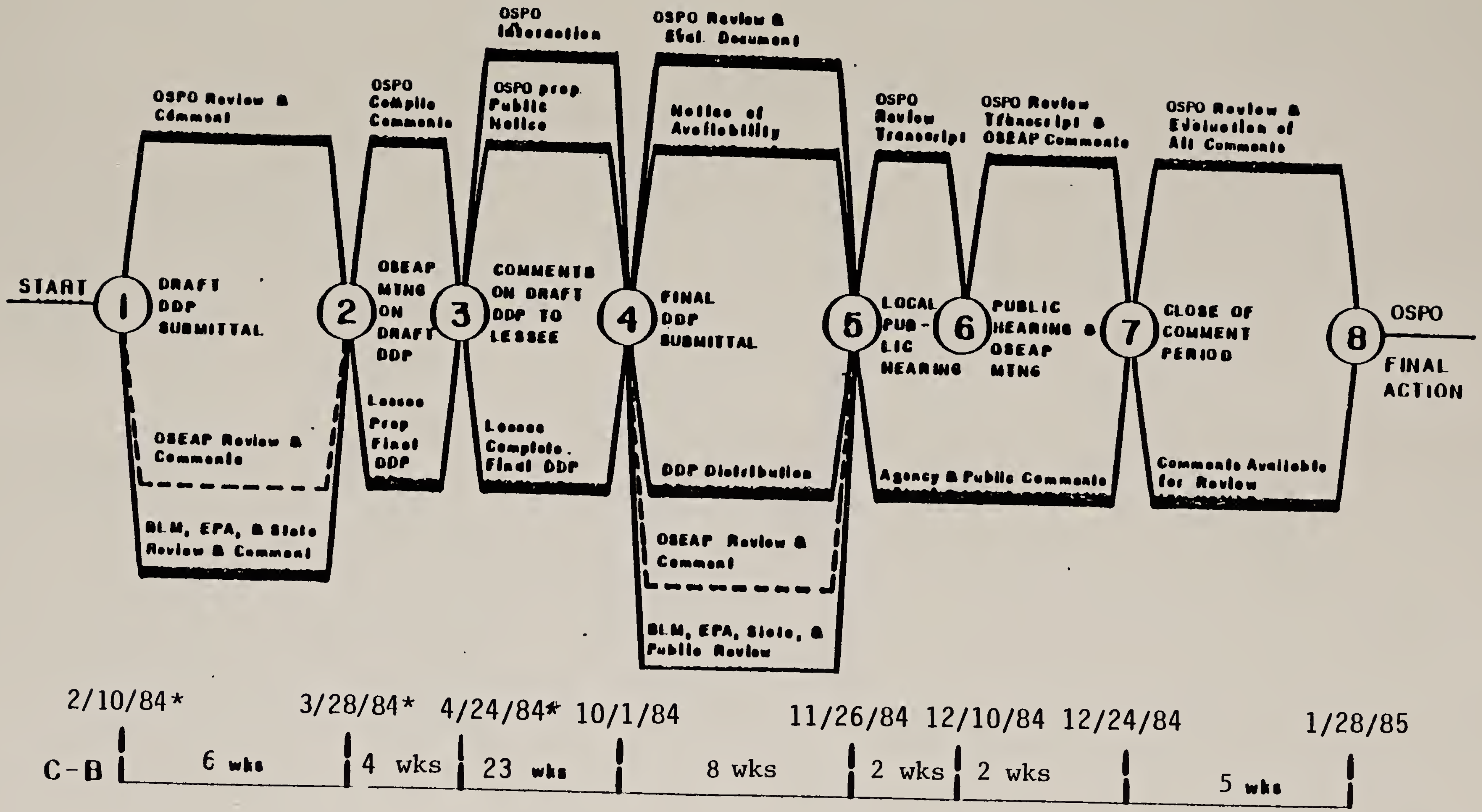
CB MASTER PROJECT SCHEDULE

RRB 5-7-84

STATUS OF SFC APPLICATION

RDDP SCHEDULE

Detailed Development Plan Review Schedule



*Actual or Scheduled
SOURCE: Bureau of Land Management, OSPO

8/10/84

PERMIT STATUS REPORT
(UPDATE)

CATHEDRAL BLUFFS SHALE OIL COMPANY
UPDATE PERMIT STATUS

CURRENT PERMITS AND APPROVALS

Covered Activities:
- Mine Dewatering, Water Handling and Discharge
- Monitoring and Reclamation Tests
- Outfit Shafts for Hoisting
- Shaft Station Development
- Ore Sampling
- Surface Ore Handling Equipment Installation
- Mine Support Facilities Construction:
  - (Offices, Dry House, Warehouse, Shops)

FUTURE PERMITS/APPROVALS REQUIRED

Title	Approval Timing
o RDDP	Prior to Development Mining and Process Facilities Construction
o Mined Land Reclamation Amendment for MIS	Prior to Setting AGR Foundation
? o PSD/MIS Amendment	Prior to Setting MIS/SPF Foundation
o COLO APCD/APENS -MIS/SPF	Prior to Setting MIS/SPF Foundation
o UIC	*Prior to Ignition MIS
o PMN PreManufacture Notice	*90 days Prior to Production

*Estimated - Regulations still being Developed.

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MIS RDDP CONFIDENTIAL INFORMATION

MIS RDDP CONFIDENTIAL INFORMATION

OBJECTIVE

Answer Specific Questions

HOW TO DO IT

Problem with determining & who does it

- Questions Based on Lease Requirements and Need to Know
- Use Q/A Sessions
- Support by Brief Visual Aids

Check out with solicitor

- Review Specific Details - in CB Confidential Office

what happens when reviewer leaves ?

- Use Previously Published Materials to Extent Possible
    - DOE
    - Technical Papers
    - SFC Confidential Documents

Aug. 1984

OIL RECOVERY AND LONG RANGE PLANS

CB RESOURCE UTILIZATION

OVERVIEW

- INITIAL MINING PLAN
    - CURRENT MARKET
    - SYNFUELS SUPPORT
    - TECHNICAL (SUBSIDENCE, ETC.)
- TOTAL RESOURCE UTILIZATION
    - FUTURE DEVELOPMENT ON NEW HORIZONS
- ALTERNATIVE RECOVERY PLANS
    - DESIGNED TO INCREASE OIL RECOVERY
    - COMPARE OIL RECOVERY FROM VARIOUS ALTERNATIVE PLANS.
- LONG-TERM DEVELOPMENT ALTERNATIVE PLAN
    - PHASED MIS PLAN
- LONG-RANGE RESOURCE UTILIZATION PLAN
    - TOTAL RESOURCE DEVELOPMENT STARTING FROM INITIAL PLAN

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CB INITIAL MINE PLAN

- COMBINED AGR AND MIS OIL PRODUCTION OF 14,100 BPCD SYNCRUDE.

- RAW SHALE OIL PRODUCTION OF 11,000 BPCD AGR AND 2,260 BPCD MIS

- 40-GPT AGR FEEDSTOCK 4.7 MM TPY SUPPLIED FROM ROOM AND PILLAR 3.9 MM TPY AND MIS 0.8 MM TPY MINING OPERATIONS.

- 40-FT HIGH ROOM AND PILLAR SECTION 15-FT TOP SLICE AND 25-FT BENCH WITH ACCELERATED TOP SLICE AND DELAYED BENCH TO GIVE HIGHER GRADE.

- 278-FT HIGH MIS SECTION WITH THREE VOID LEVEL RETORT DESIGN PREVIOUSLY DEMONSTRATED FULL SCALE AT LOGAN WASH MINE.

- FIVE MIS RETORTS PROCESSED ANNUALLY WITH FOUR RETORTS RUNNING SIMULTANEOUSLY.

- MINE DESIGNED TO PRODUCE MINIMAL TO NON-SUBSIDING CONDITIONS ON GROUND SURFACE OVER THE MINE.

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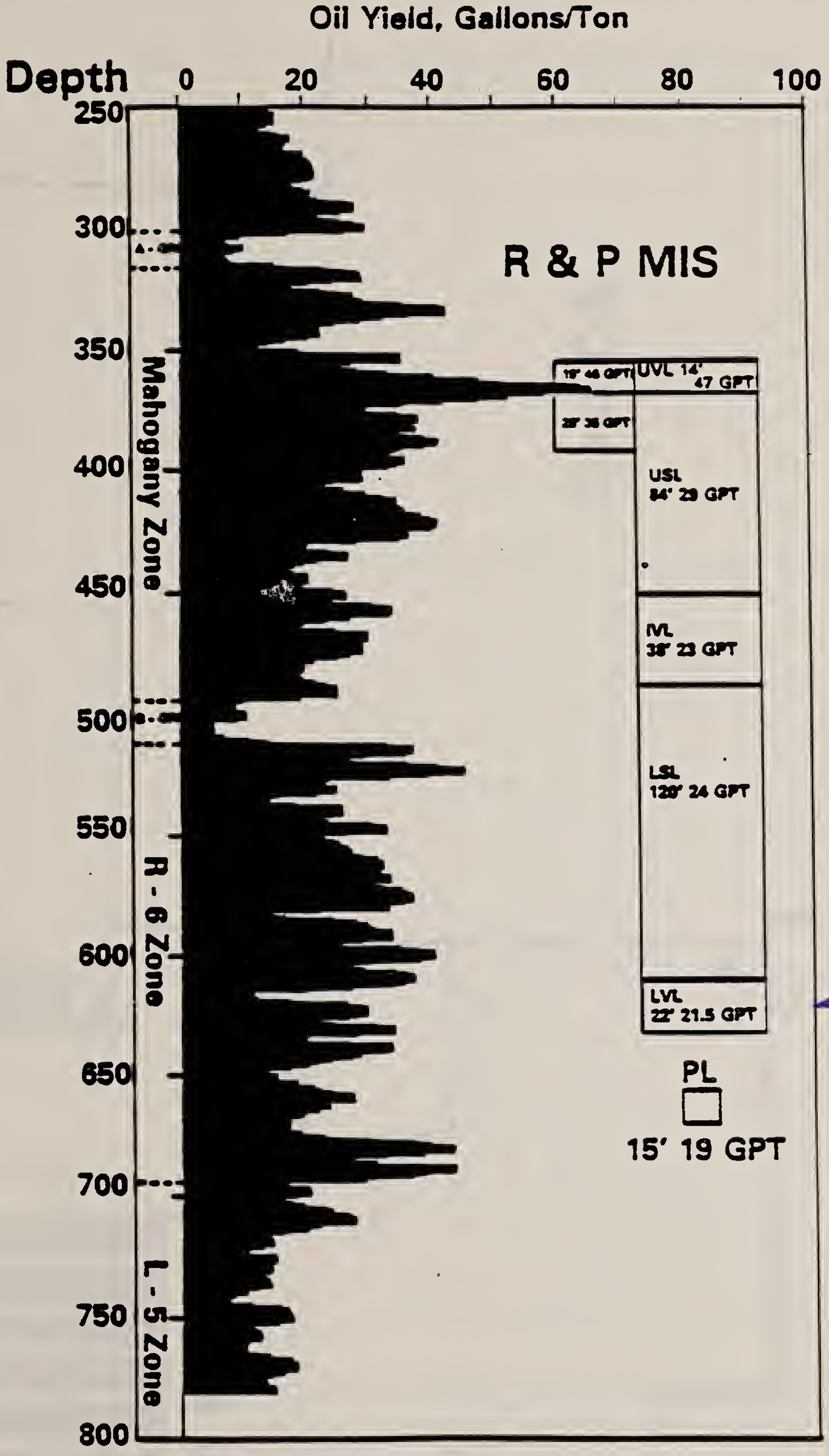
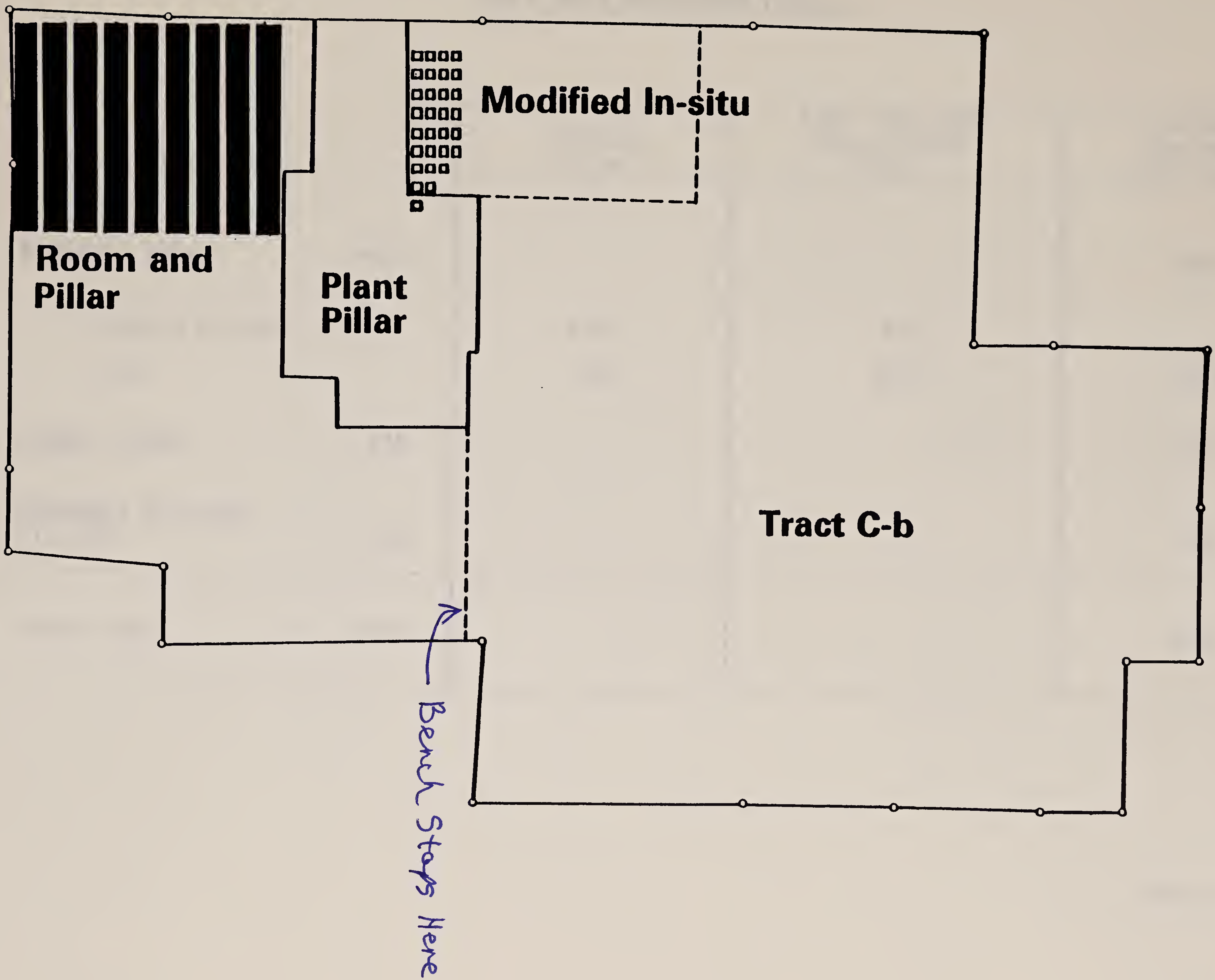
MIS and R & P Station Layout
vs
Richness Log

AVG CB Corehole



← Existing Shaft Levels

CB INITIAL MINE PLAN



CB MINE PLAN

TRACT AREA BREAKDOWN (ACRES)

Tract Area		Initial Plan	Long-Term MIS Development Plan	Future Horizons MIS Plans
MINEABLE AREA	4481			4396
Room & Pillar		4146	858	0
MIS		335	3623	4396
PLANT PILLAR	418			503
BOUNDARY SET-BACK PILLARS	195			195
TOTAL TRACT	5094			5094

TER:PH 7/25/84

CB INITIAL MINE PLAN

OIL RECOVERY

Area	In Place Oil (*) (MM Bbls)	Recovered Raw Shale Oil (MM Bbls)
ROOM & PILLAR 4146 acres mostly only the 15 ft top slice	261.4	109.1
MIS 335 acres	172.7	38.9
TOTALS	434.1	148.0

(*) Calculated using only the horizon where actual mining activities occur.

Note: Total fines production would be 9.2 MM barrels which is 6.2% of total recovered oil and 2.1% of oil in place. Initial 5 years build-up period fines oil production would be 0.1% of oil in place.

TER:PH 7/31/84

TOTAL RESOURCE UTILIZATION

- INITIAL MINE PLAN DOES NOT PRECLUDE FUTURE RESOURCE UTILIZATION.
    - IN THE PRESENT MINING HORIZON.
    - IN NEW HORIZONS WITHIN THE OVERALL DEPOSIT.

- PRESENT MINING HORIZON HAS POTENTIAL FOR SUBSTANTIAL ADDITIONAL OIL RECOVERY.
    - ALTERNATE RECOVERY PLANS

TER:PH 7/10/84

RESOURCE DEVELOPMENT BELOW PRESENT MINING HORIZON

1900 - 2000 ft thick deposit

- TOTAL DEPOSIT REPRESENTS 13.2 BILLION BARRELS OF IN PLACE OIL FOR THE TOTAL TRACT OR 11.5 BILLION BARRELS FOR THE MINEABLE AREA.

- AT LEAST THREE, AND POSSIBLY FOUR OR MORE, MINING HORIZONS CAN BE LOCATED IN THE DEPOSIT.

- FOUR MINING HORIZONS RESULT IN A RESOURCE RECOVERY OF 41% OF THE 11.5 BILLION BARRELS IN PLACE.

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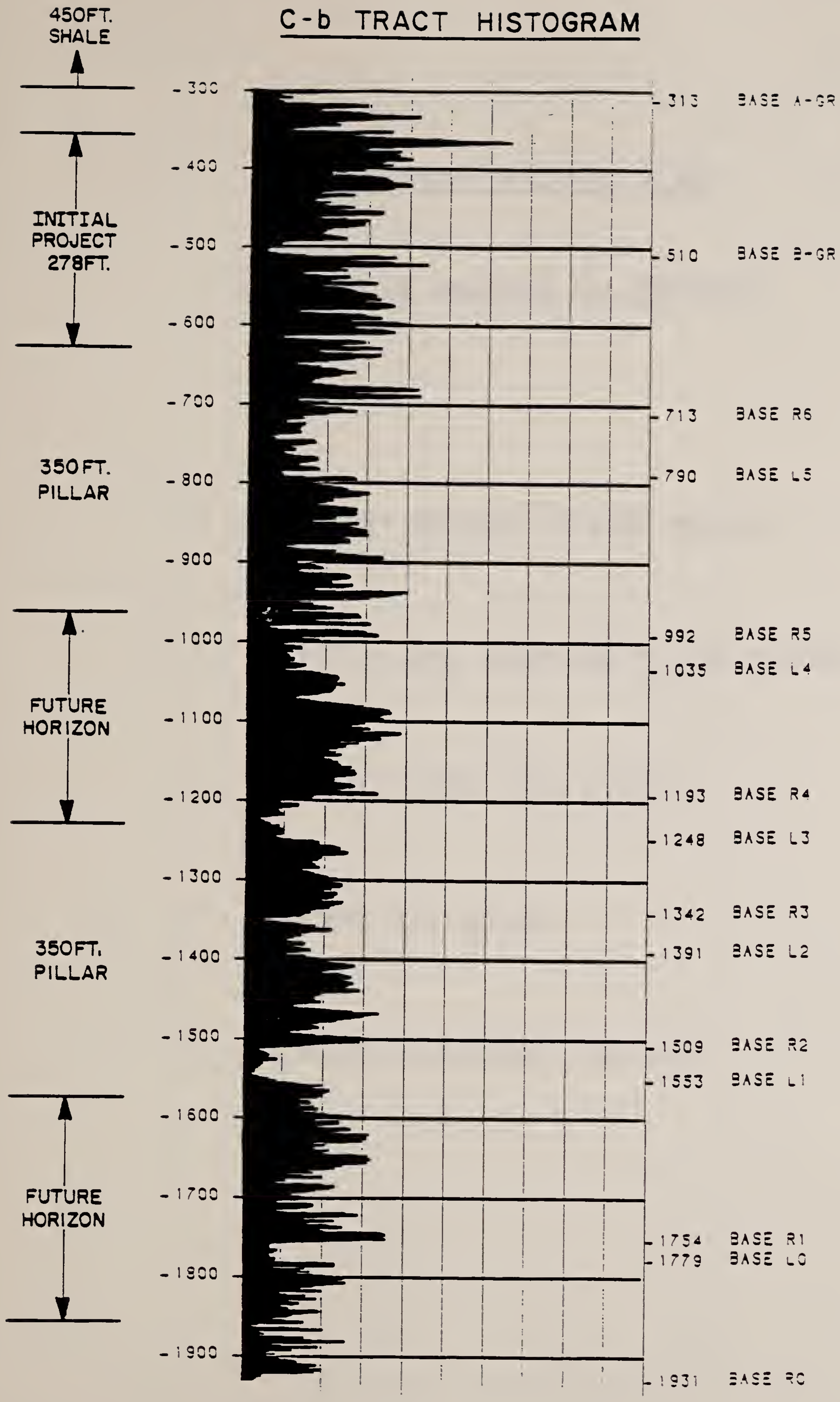
C-b TRACT HISTOGRAM

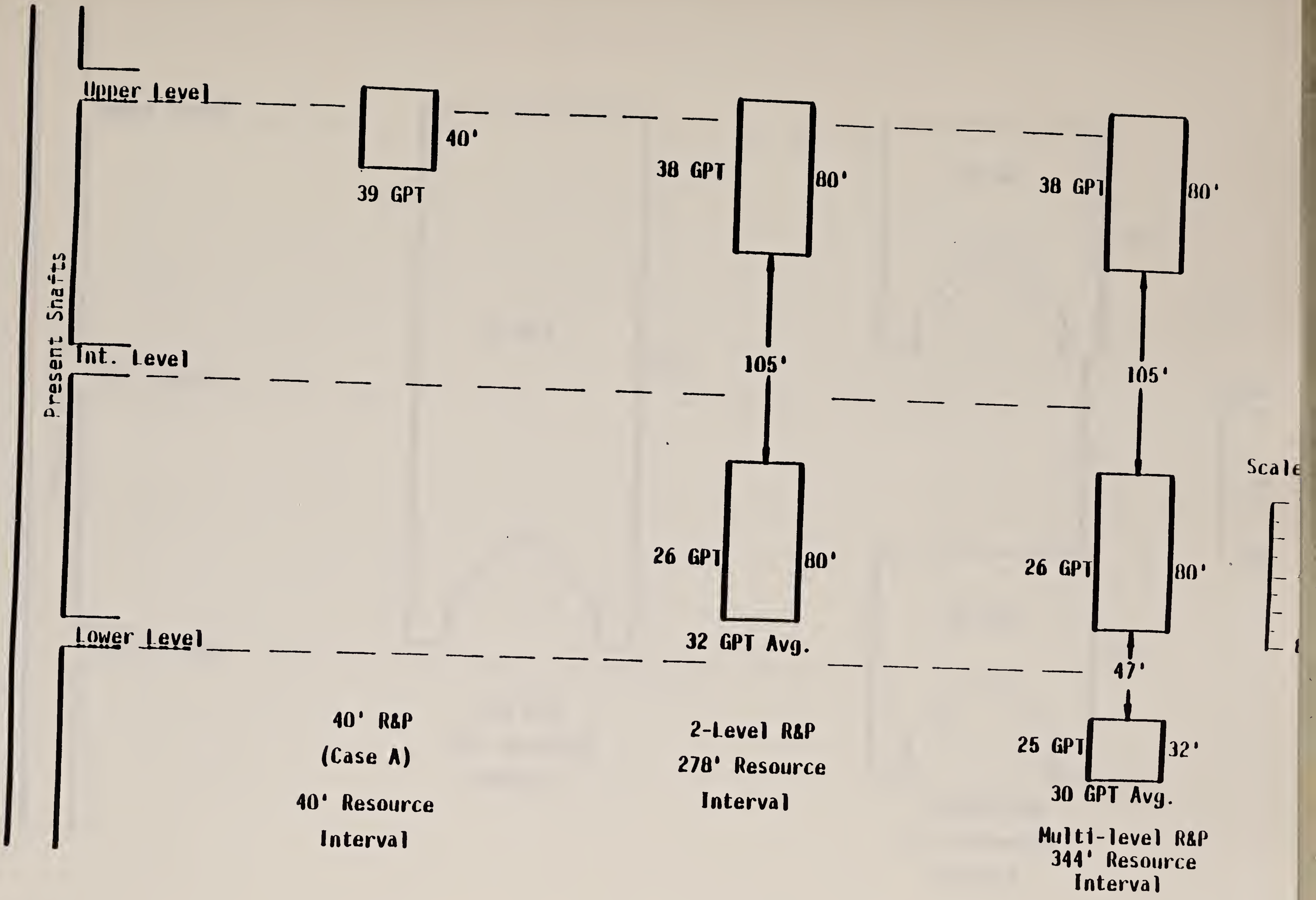


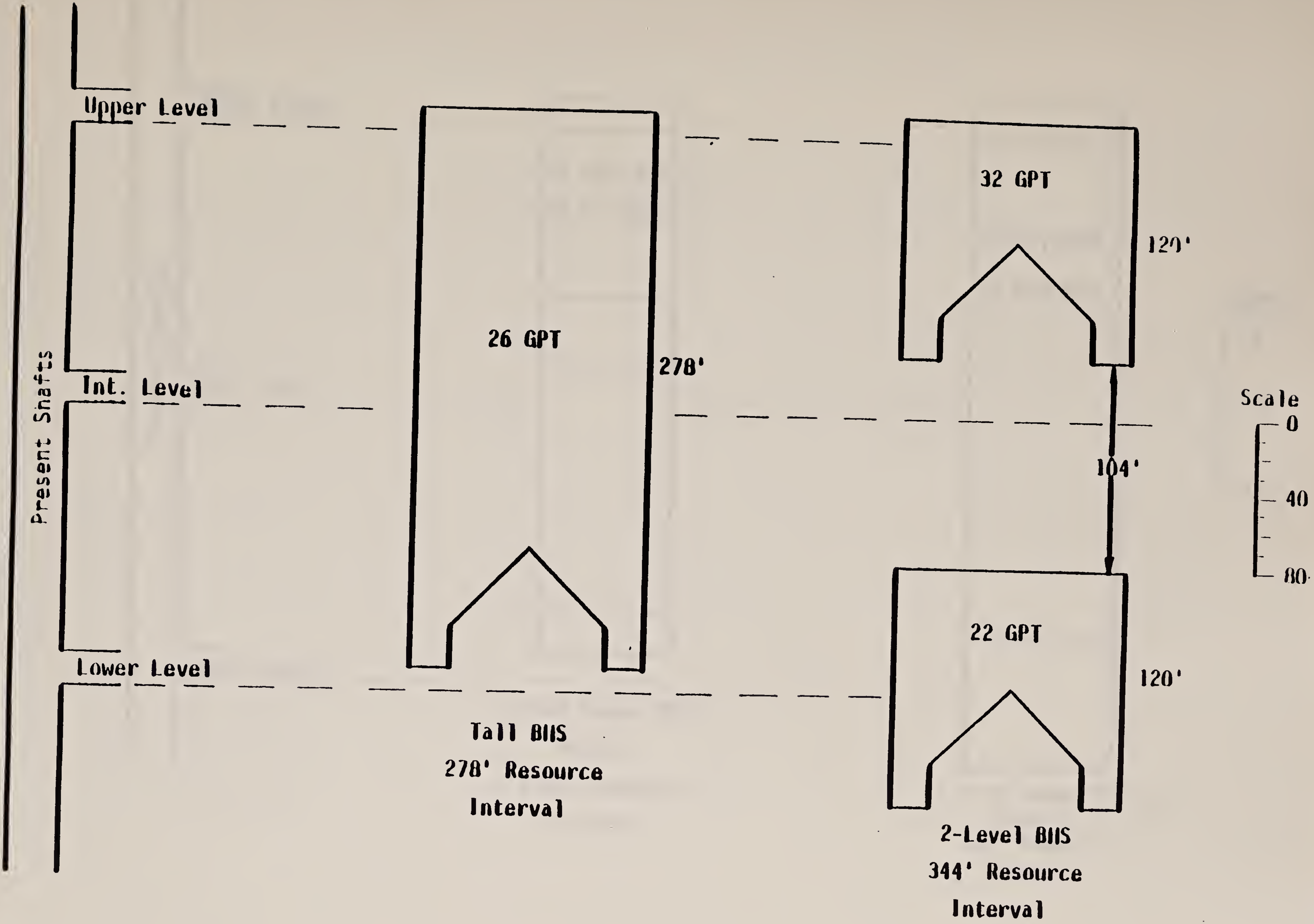
ALTERNATIVE RECOVERY PLANS

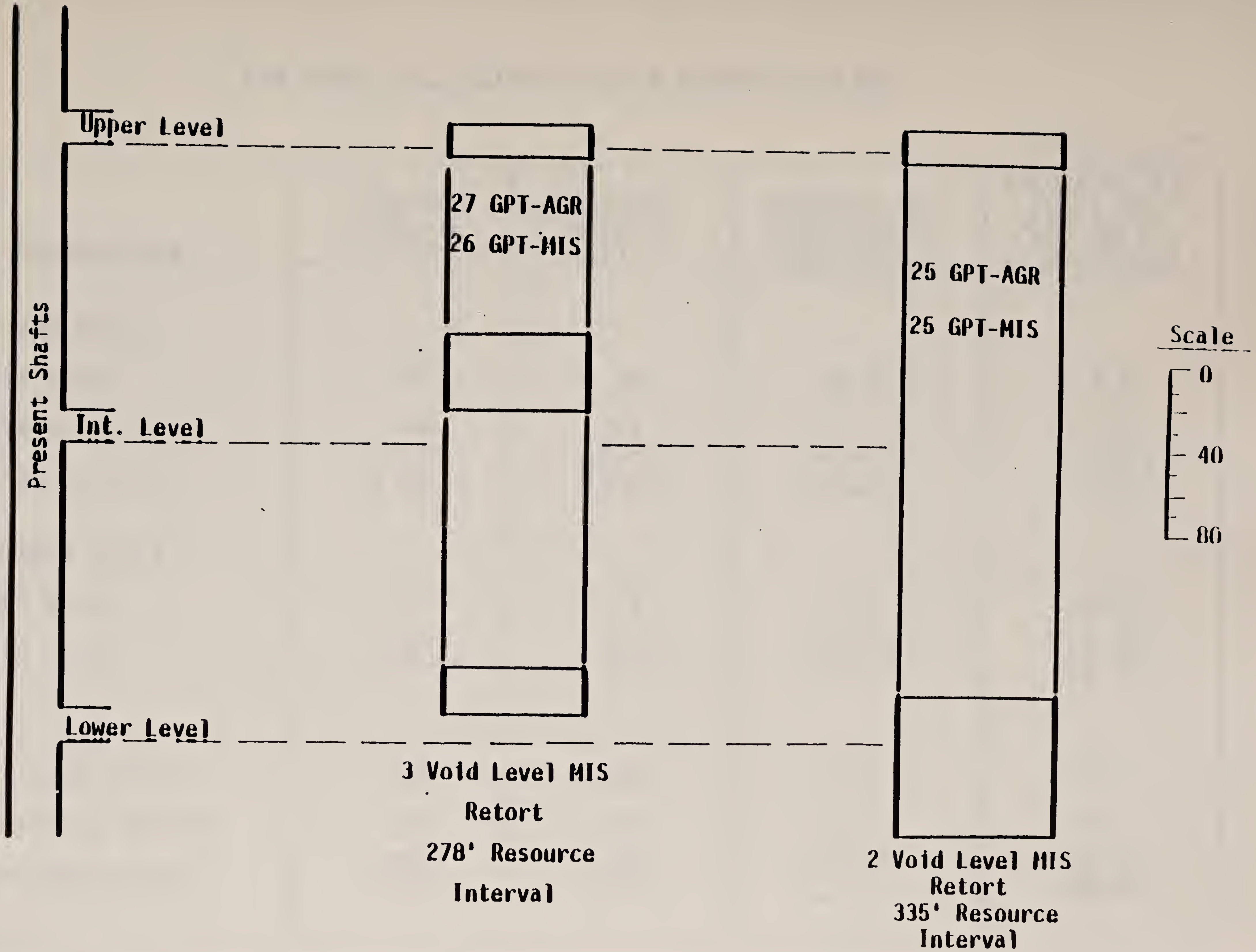
DESIGNED TO INCREASE OIL RECOVERY

- SECONDARY RECOVERY MINING METHODS
- MULTIPLE-LEVEL ROOM AND PILLAR MINING
- BLASTHOLE STOPE BULK MINING
- IMPROVED MIS DESIGN
- INCREASED SUBSIDENCE DESIGNS

TER:PH 7/30/84


Upper Level
Int. Level
Lower Level
Present Shafts
40'
39 GPT
38 GPT
80'
105'
26 GPT
80'
32 GPT Avg.
38 GPT
80'
105'
26 GPT
80'
47'
25 GPT
32'
30 GPT Avg.
40' R&P
(Case A)
40' Resource
Interval
2-Level R&P
278' Resource
Interval
Multi-level R&P
344' Resource
Interval
Scale


Present Shafts
Upper Level
Int. Level
Lower Level
26 GPT
278'
Tall BHS
278' Resource
Interval
32 GPT
120'
104'
22 GPT
120'
2-Level BHS
344' Resource
Interval
Scale
0
40
80


Present Shafts
Upper Level
Int. Level
Lower Level
27 GPT-AGR
26 GPT-MIS
25 GPT-AGR
25 GPT-MIS
Scale
0
40
80
3 Void Level MIS
Retort
278' Resource
Interval
2 Void Level MIS
Retort
335' Resource
Interval

RAW SHALE OIL RECOVERY FOR ALTERNATIVE PLANS

within mined interval

Mining Plan	Mining Interval (Ft)	Resource Interval (Ft)	In Place Oil (MM Bbls/ 100 Acres)	Recovered Raw Shale Oil* (MM Bbls/ 100 Acres)
Room and Pillar				
One Level	40	40	10.2	3.8
Two Level	160	278	51.5	9.8
Three Level	192	344	62.3	11.9
Blasthole Stope				
One Level	278	278	51.5	10.7
Two Level	240	344	62.3	13.2
MIS **				
Initial Plan	278	278	51.5	11.6
Improved Design	335	344	62.3	19.4
Optimum Design	335	344	62.3	28.6

* Values do not account for plant pillar and boundary setback pillars.

** MIS calculations use a recovered oil yield value of 0.695.

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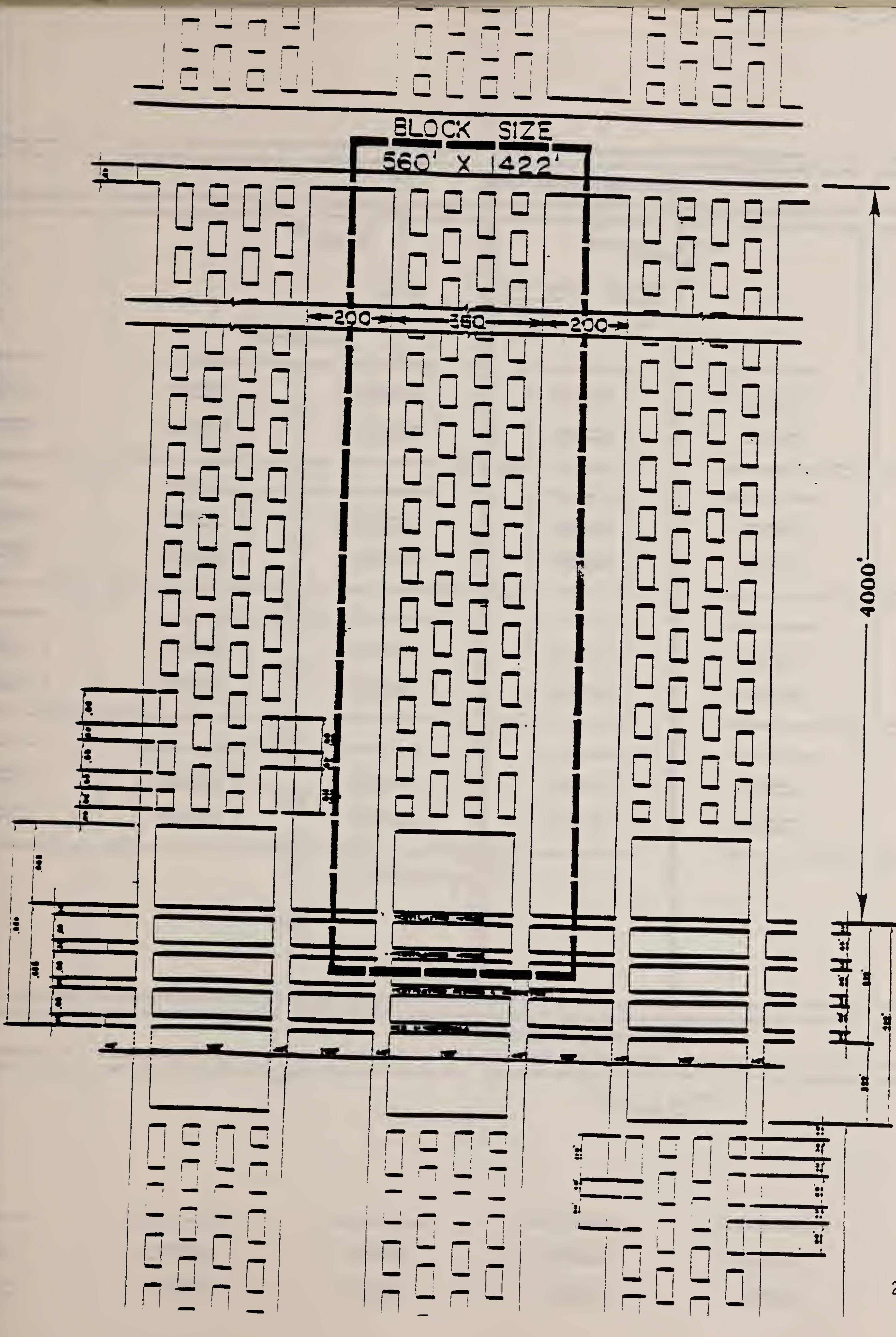
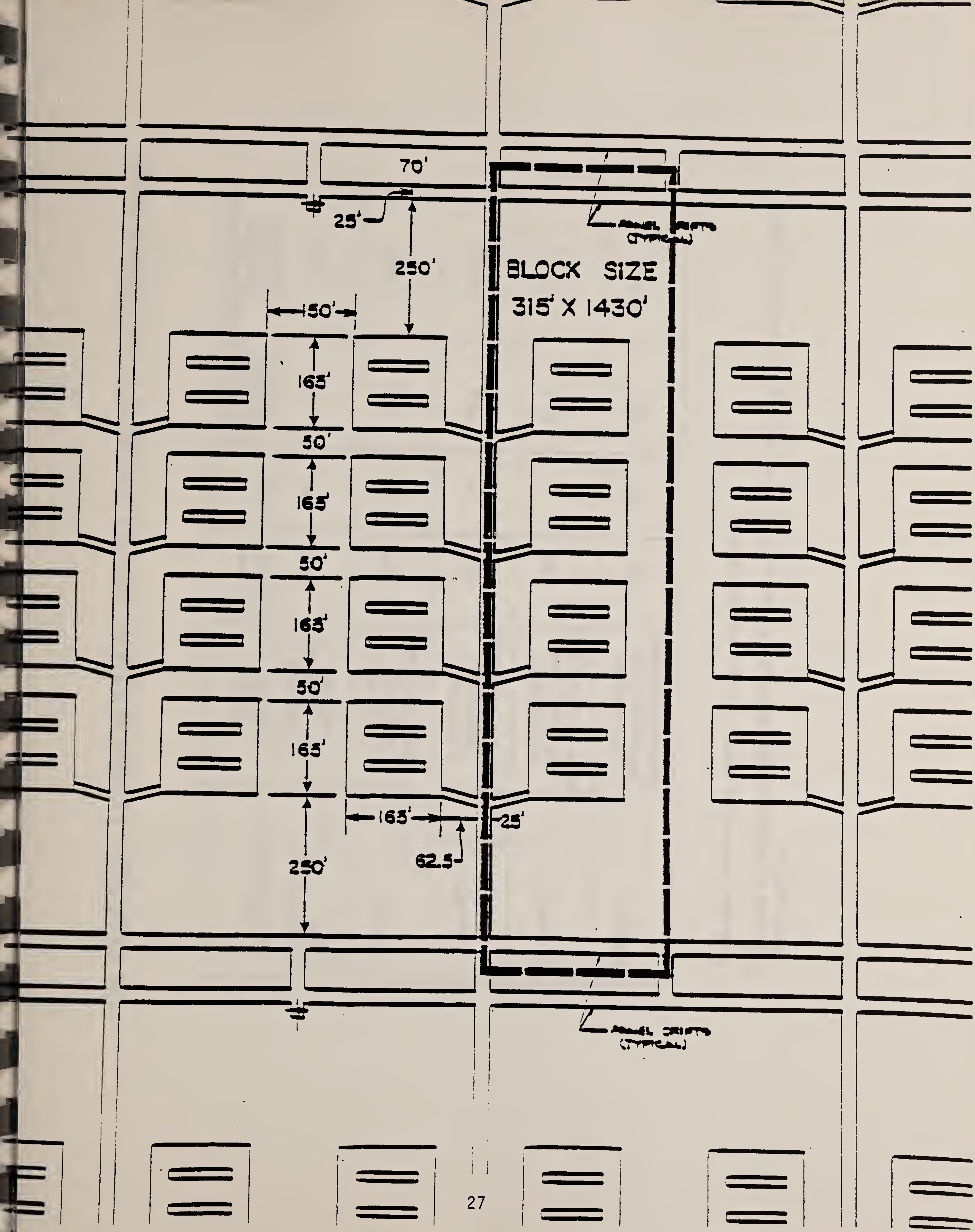
Rev.1


BLOCK SIZE
560' X 1422'


70'
25'
250'
150'
BLOCK SIZE
315' X 1430'
PANEL DRIFTS
(TYPICAL)
165'
50'
165'
50'
165'
50'
165'
165'
25'
62.5
250'
PANEL DRIFTS
(TYPICAL)

CB PHASED LONG-RANGE DEVELOPMENT ALTERNATIVE

Mining Plan	Type of Mining	Acres Used	Years	Annual Raw Shale Oil MM Bbls	Cumulative Raw Shale Oil MM Bbls
Initial Phase I Plan 278'	1-AGR Unit Room and Pillar and MIS	935	10	4.84	32.2*
Phase II 335'	1-AGR Unit MIS Only; Non-Subsiding	188	4	9.2	69.0
Phase III**	2-AGR Units MIS Only; Minimal-Subsiding	322	4	18.8	144.2
Phase IV**	3-AGR Units MIS Only; Controlled-Subsiding	400	4	28.7	259.0
Phase V	4-AGR Units MIS Only; Controlled Subsiding	2636	20	38.2	1012.

* Includes production during 5 years buildup period

** Phases III and IV consist of several increments of mine redesign to reach the Phase V final design.

LONG-RANGE DEVELOPMENT ALTERNATIVE PLAN

- LONG-RANGE PLAN REPRESENTS A BALANCE BETWEEN RESOURCE RECOVERY AND CONTROLLED SUBSIDENCE.

- LONG-RANGE PLAN SIGNIFICANTLY INCREASES OIL RECOVERY WITHIN A SINGLE MINING HORIZON FROM 148 MM BARRELS TO 1012 MM BARRELS OF RAW SHALE OIL.

- TOTAL FINES PRODUCTION OVER LIFE OF PROJECT COULD BE 1% OF OIL IN PLACE.

- POTENTIAL OIL PRODUCTION FROM FINES DURING INITIAL 5 YEARS BUILD-UP PERIOD WOULD BE 0.03% OF OIL IN PLACE.

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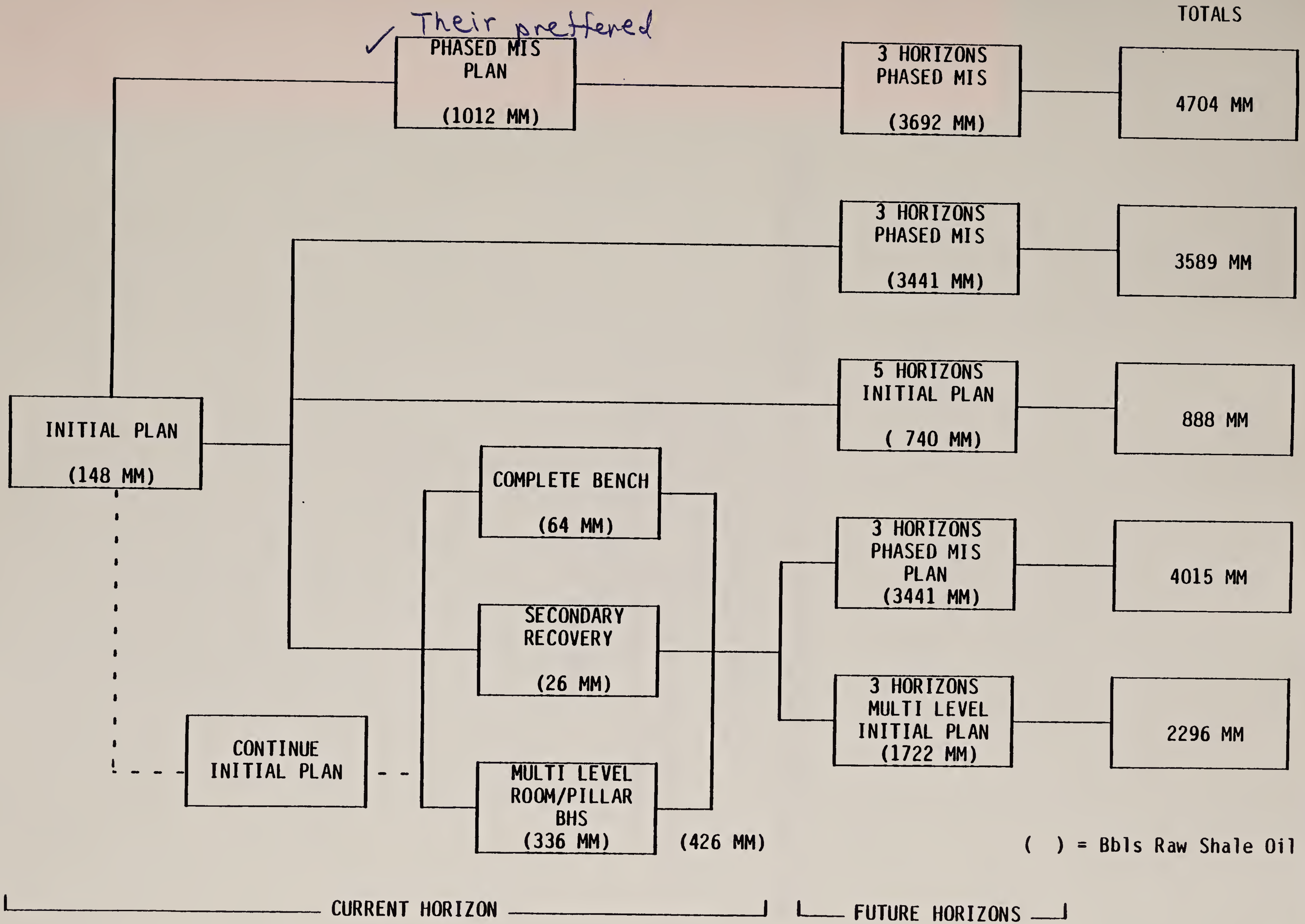
LONG-TERM RESOURCE UTILIZATION PLAN


✓ Their preffered
TOTALS
PHASED MIS PLAN (1012 MM)
3 HORIZONS PHASED MIS (3692 MM)
4704 MM
3 HORIZONS PHASED MIS (3441 MM)
3589 MM
5 HORIZONS INITIAL PLAN (740 MM)
888 MM
INITIAL PLAN (148 MM)
COMPLETE BENCH (64 MM)
3 HORIZONS PHASED MIS PLAN (3441 MM)
4015 MM
SECONDARY RECOVERY (26 MM)
3 HORIZONS MULTI LEVEL INITIAL PLAN (1722 MM)
2296 MM
CONTINUE INITIAL PLAN
MULTI LEVEL ROOM/PILLAR BHS (336 MM)
(426 MM)
( ) = Bbls Raw Shale Oil
CURRENT HORIZON
FUTURE HORIZONS

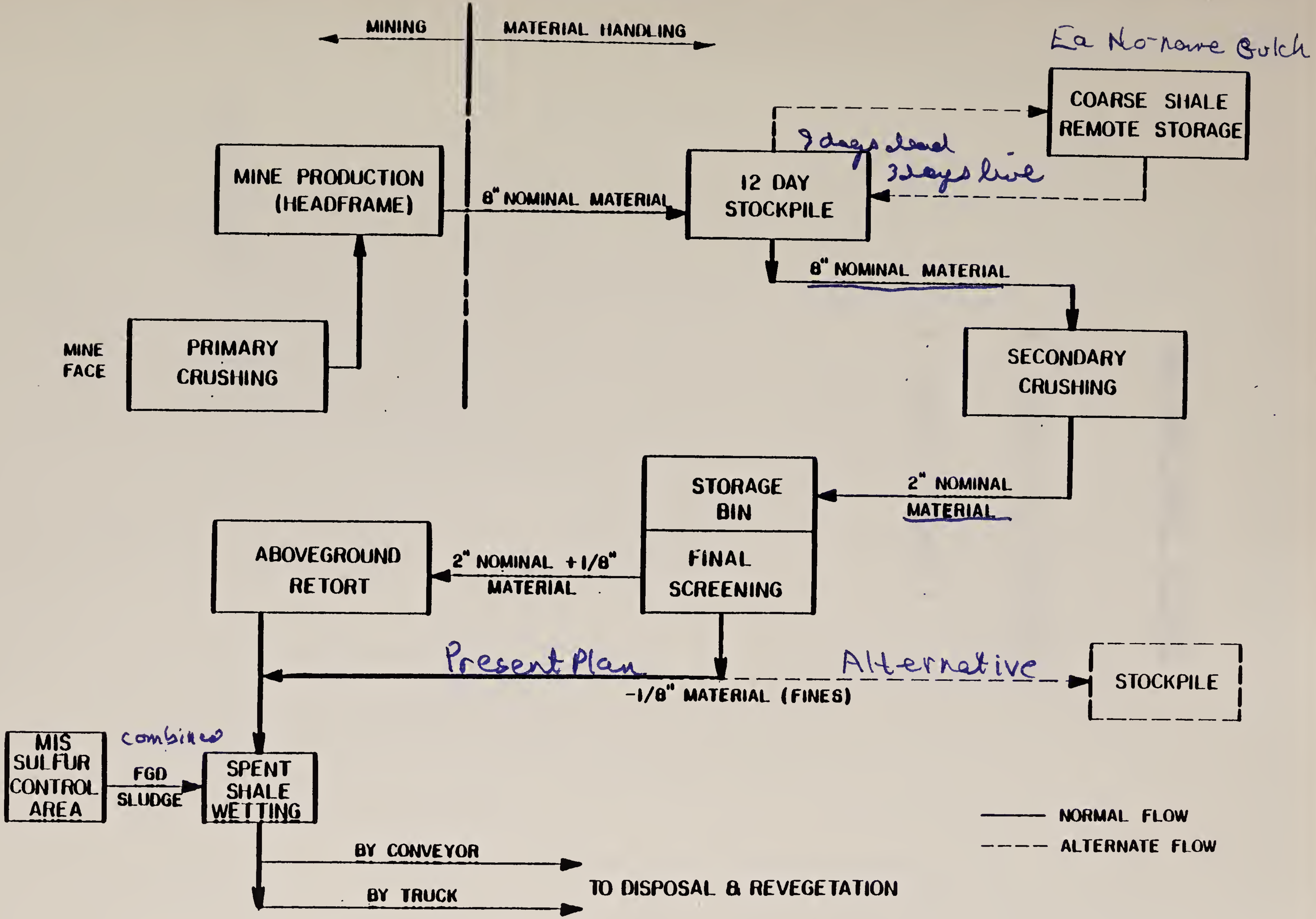
TER:ph 7/23/84

Dig
4
Web
3·19

ABOVE GROUND RETORTING/SHALE PREPARATION AND HANDLING (AGR)

- OVERALL MATERIALS HANDLING
- RAW SHALE FINES
- PROCESSING, ORE FEED GRADE AND MINERALOGY
- SPENT SHALE HANDLING AND DISPOSAL
  - DESIGN
  - TEST PROGRAM

DESIGN BASIS



Is this ? toxic

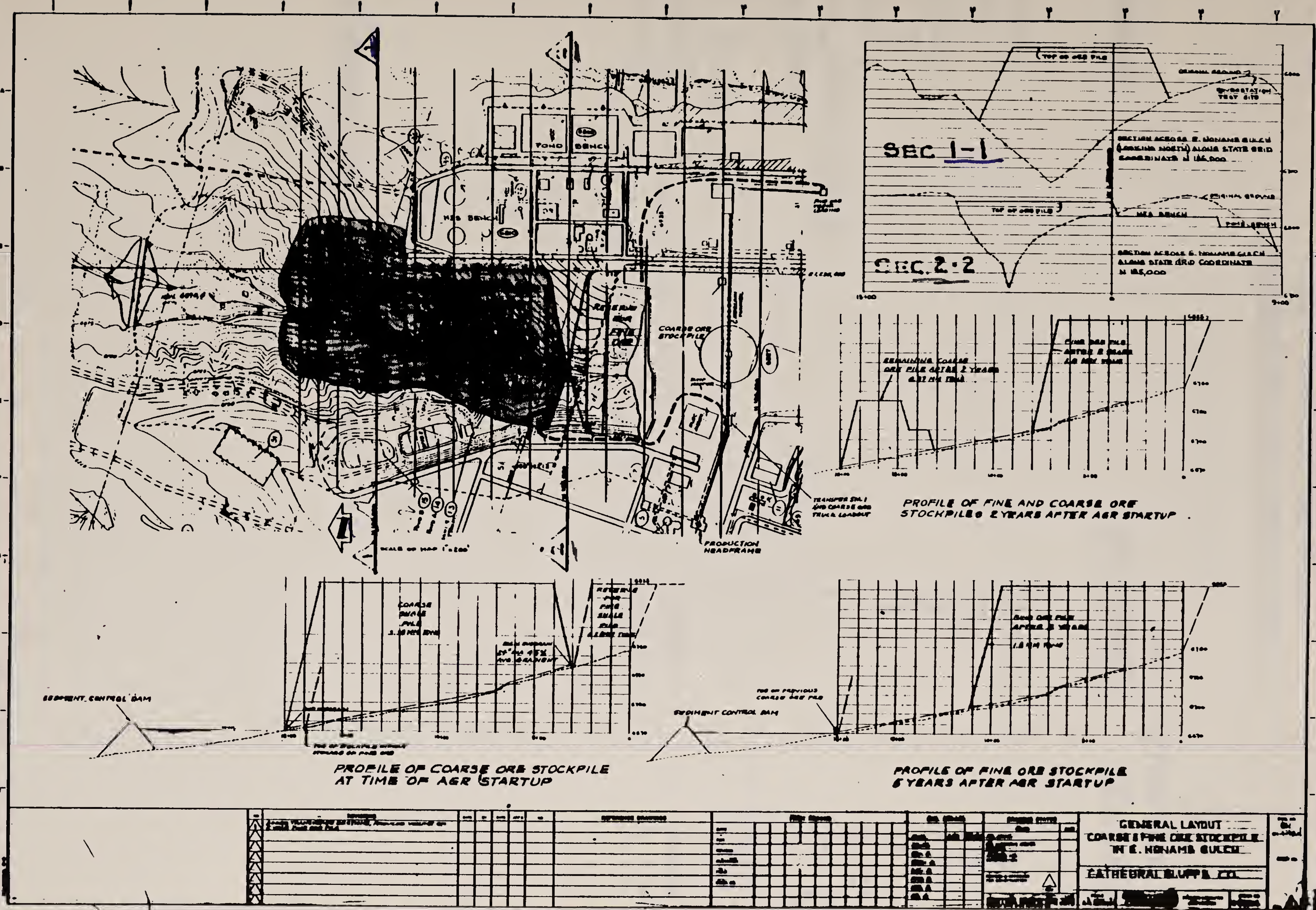
BLOCK FLOW DIAGRAM – MATERIALS HANDLING (SURFACE)

FIGURE 3.4-1

AGR RAW SHALE STORAGE

- COARSE ORE STOCKPILE
- FINES STOCKPILE

7/13/84 KRC


SEC 1-1
TOP OF ORE PILE
ORIGINAL GROUND
REVEGETATION TEST SITE
SECTION ACROSS E. NONAME GULCH (LOOKING NORTH) ALONG STATE GRID COORDINATE N 186,000
SEC. 2-2
TOP OF ORE PILE
ORIGINAL GROUND
MEA BENCH
TOMO BENCH
SECTION ACROSS E. NONAME GULCH ALONG STATE GRID COORDINATE N 185,000
COARSE ORE STOCKPILE
PRODUCTION HEADFRAME
TRANSFER SILO AND COARSE ORE TRUCK LOADOUT
SCALE OF MAP 1"=200'
REMAINING COARSE ORE PILE AFTER 2 YEARS
FINE ORE PILE AFTER 2 YEARS
PROFILE OF FINE AND COARSE ORE STOCKPILES 2 YEARS AFTER AGR STARTUP
COARSE SHALE PILE
SEDIMENT CONTROL DAM
PROFILE OF COARSE ORE STOCKPILE AT TIME OF AGR STARTUP
TOE OF PREVIOUS COARSE ORE PILE
SEDIMENT CONTROL DAM
FINE ORE PILE AFTER 5 YEARS
PROFILE OF FINE ORE STOCKPILE 5 YEARS AFTER AGR STARTUP
GENERAL LAYOUT
COARSE & FINE ORE STOCKPILE IN E. NONAME GULCH
CATHEDRAL BLUFFS CO.

[redacted]

AGR RAW SHALE
(R&P TOPSLICE AND BENCH)
MINERALOGY AND COMPOSITION

	X-RAY DIFFRACTION		
MINERALOGY	PEAK HEIGHTS	EST. WT. %	
DOLOMITE	78	23%	
QUARTZ	93	11%	
DAWSONITE	10	1.9%	
CALCITE	18	3%	
ANALCITE	-*	0.3%*	
NA-FELDSPAR (ALBITE)	31	-	} Too high temp minerals to affect AGR Heat requirements
K-FELDSPAR	11	-	
PYRITE	5	<1%*	
MG-SIDERITE	5	-	
ARAGONITE	TRACE	TRACE	
NAHCOLITE	TRACE	0.1%*	because Mahogony = leached zone

*% DETERMINED BY CHEMICAL ANALYSIS

JNS/SB 7/11/84

RAW SHALE LEACHATE

I STUDY PERFORMED IN 1981-1982 BY COLORADO STATE UNIVERSITY. Mcwhorter

II COMPARE C-A AND C-B ROCK.

R-5 Rich

B-Groove lowest grade- not representative of AGR Feed

III CONCLUSION: LOW GRADE ROCK (C-B) LEACHATE IS BETTER WATER QUALITY THAN HIGH GRADE ROCK (C-A).

JNS 8/1/84

RAW SHALE LEACHATE

- PERFORM ADDITIONAL BENCH TESTS ON HIGH GRADE (AGR FEED) C-B ROCK.

- CONSTRUCT NEW TEST PLOT AT C-B USING HIGH GRADE (TOPSLICE) ROCK AND PERFORM LEACHATE STUDY.

JNS 8/1/84

DISPOSAL OF RAW SHALE FINES

CONSIST SIZE: -1/8"

AMOUNT:
- 8% OF MINED AND CRUSHED SHALE
- 374,000 TONS/YR

ESTIMATE OF OIL RECOVERY FROM FINES RETORTING:

A. PHASE I (34-YR PLAN)

- 2.1% OF OIL IN PLACE OVER 34 YRS (6.2% OF RECOVERED OIL).
- 0.1% OF OIL IN PLACE OVER FIRST 5 YRS.

6.2 ≠ E because of MIS

B. LONG-RANGE PLAN

MIS increases, so lost oil from disposing of fines gets less & less

- 1% OF OIL IN PLACE OVER LIFE OF THE PROJECT (2.3% OF RECOVERED OIL).
- 0.03% OF OIL IN PLACE OVER FIRST 5 YRS.

8/1/84 KRC

SHORT-TERM ALTERNATES FOR UTILIZATION OF FINES

A. INSTALL FACILITIES FOR

- RETORTING
- COMBUSTION OF FINES (make steam)

B. DISPOSE OF RAW SHALE FINES UNTIL MEANS FOR RETORTING FINES ARE ESTABLISHED

- CODISPOSE FINES WITH SPENT SHALE
- STOCKPILE SEPARATELY

8/1/84 KRC

ALTERNATE A

INSTALL PROCESSING FACILITIES NOW

RETORTING

- LURGI-LR, TOSCO II, CHEVRON STB
- PILOT PLANT & SEMI-WORKS SCALE
- NOT COMMERCIAL

COMBUSTION

- SO_X AND NO_X EMISSION REDUCTION (Fluidized bed)
  mostly coal
- SMALL SCALE TESTS
- NOT COMMERCIAL

8/1/84 RTS

ALTERNATE B

CODISPOSAL VERSUS STOCKPILING

	INCREMENTAL COST INCREASE	
	CAPITAL ($)	OPERATING ($/YR)
A. CODISPOSAL OF RAW SHALE FINES WITH AGR SPENT SHALE	NIL	NIL
B. STOCKPILING OF RAW SHALE FINES	$500,000	$240,000

8/1/84 KRC

[illegible]

[illegible]

[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

CONCLUSIONS

RETORTING/COMBUSTION

- ADDS TO PROJECT COST
- ADDS TO PROJECT RISK
- PROCESSES NOT PROVEN COMMERCIALLY
- FINES RATE TOO SMALL TO JUSTIFY DEVELOPING NEW TECHNOLOGY

STOCKPILING

- ADDS TO PROJECT COST
- NO ASSURANCE WILL EVER BE UTILIZED

  but could be codisposed

8/3/84 RTS

INITIAL PLAN

CO-DISPOSE RAW SHALE FINES WITH SPENT SHALE UNTIL ECONOMICAL MEANS FOR UTILIZATION HAVE BEEN ESTABLISHED.

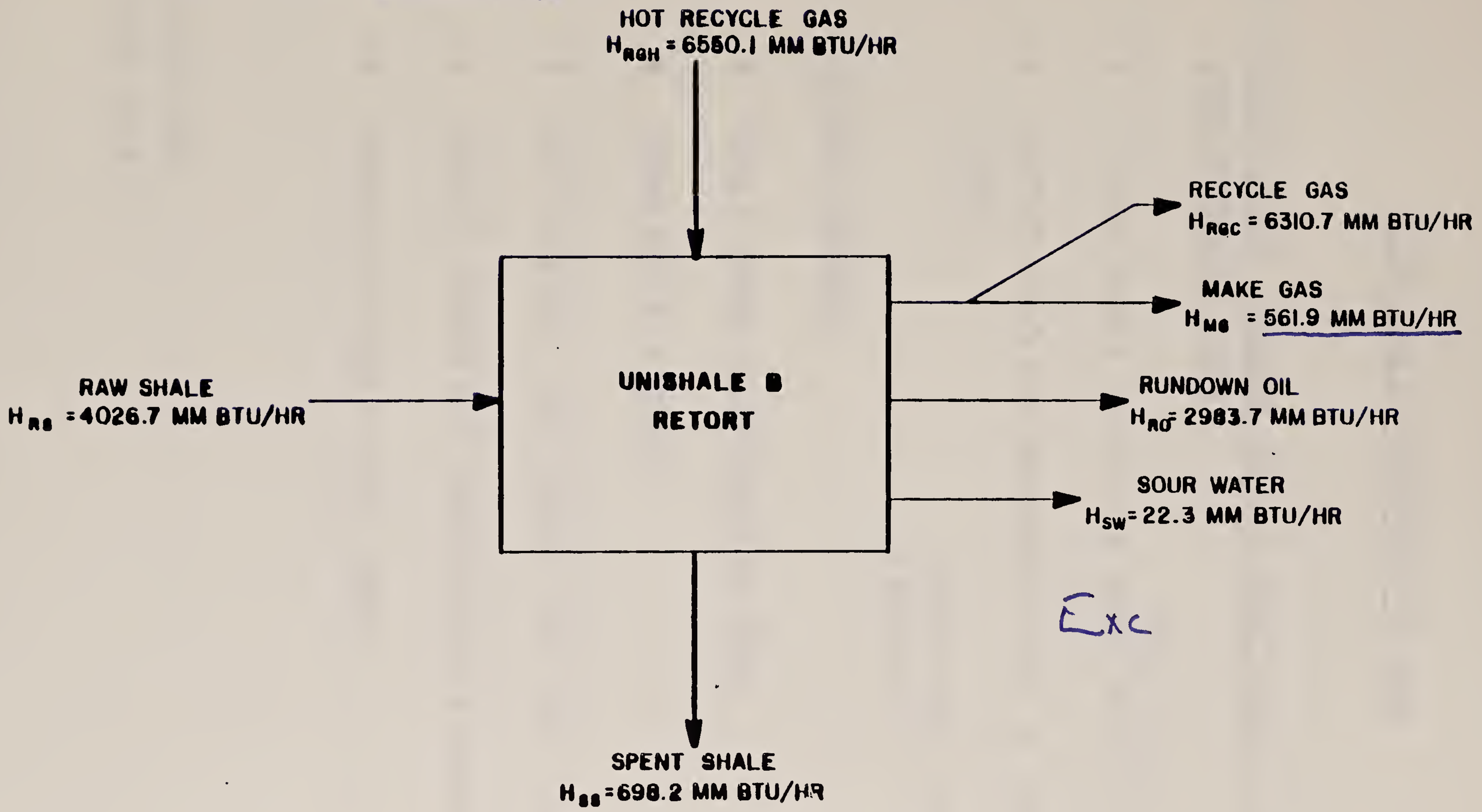
* Must look at methane emissions at co-disposal temperature & possible auto-combustion in spent shale pile.

8/3/84 RTS

UNISHALE B RETORT ENERGY BALANCE

From Public Domain

40 GPT Raw Shale



HOT RECYCLE GAS
H_{RGH} = 6550.1 MM BTU/HR
RECYCLE GAS
H_{RGC} = 6310.7 MM BTU/HR
MAKE GAS
H_{MG} = 561.9 MM BTU/HR
RAW SHALE
H_{RS} = 4026.7 MM BTU/HR
UNISHALE B
RETORT
RUNDOWN OIL
H_{RO} = 2983.7 MM BTU/HR
SOUR WATER
H_{SW} = 22.3 MM BTU/HR
SPENT SHALE
H_{SS} = 698.2 MM BTU/HR

Exc

REF. TEMP. = 77°F LIQUID WATER

RAW SHALE FA = 40 GPT

$H = H_C + H_S + H_\lambda$

H_C = COMBUSTION ENTHALPY (HHV)

H_S = SENSIBLE ENTHALPY

H_λ = LATENT HEAT ENTHALPY

RICH SHALE FEEDSTOCK TO AGR

A. PILOT PLANT STUDIES ON C-B TRACT SHALE (OCTOBER 1983-FEBRUARY 1984):

Top Slice Material only

- TESTED SHALE IN THE FA RANGE OF 35 TO 43 GPT
- RETORT FEED NOT REPRESENTATIVE OF COMMERCIAL MINE BLEND

Noticed some agglomeration problems

B. FUTURE STUDIES:

- SHALE GRADE DISTRIBUTION TESTS
- PERMEABILITY TESTS
- SUPPLEMENTAL AGR DESIGN TEST RUN with true AGR feed
- RETORT PARAMETRIC ENGINEERING EVALUATION STUDIES
- PARACHUTE CREEK PLANT INPUT

7/13/84 KRC
8/9/84 (REV.1)

AGR SPENT SHALE

MINERALOGY AND COMPOSITION

A. MINERALOGY

	X-RAY DIFFRACTION PEAK HEIGHTS			
	RAW SHALE		SPENT SHALE	
DOLOMITE	78	(23.5%)	72	(21.0%)
QUARTZ	93	(11.0%)	96	(12.0%)
DAWSONITE	10	(1.9%)	ND	
CALCITE	18	(3.0%)	19	(3.0%)
ANALCITE	ND		A	(0.3%)[1]
ALBITE	31		34	
K-FELDSPAR	S		S	
PYRITE	5	(<1.0%)[2]	ND	
MG-SIDERITE	5		ND	
NAHCOLITE	TR	(0.1%)[1]	-	

ND - NOT DETECTABLE

S - K-FELDSPAR FORMING UNMEASURABLE SHOULDER ON ALBITE PEAK

A - COLLAPSED (DEHYDRATED) ANALCITE

TR - TRACES

1 - AS DETERMINED BY CHEMICAL ANALYSIS

2 - ESTIMATED

NUMBERS IN PARENTHISES ARE WT% RAW SHALE

7/13/84 KRC

AGR SPENT SHALE

MINERALOGY AND COMPOSITION

B. COMPOSITION

1. ELEMENTAL ANALYSES OF SPENT SHALE DERIVED FROM OCTOBER 1983-FEBRUARY 1984 AGR TEST RUN HAVE BEEN COMPLETED.

2. FUTURE STUDIES INCLUDE DETERMINATION OF CHEMICAL COMPOSITION OF SPENT SHALE DERIVED FROM FORTHCOMING AGR PILOT PLANT STUDIES.

Trace metals

when?

7/13/84 KRC

RAW AND SPENT SHALE ELEMENTAL ANALYSES

From "Top Slice"
Upper void Mahogany Bed

	RAW SHALE	SPENT SHALE
FISCHER ASSAY, GPT	37.30	-
TOTAL CARBON, WT%	22.44	10.85
MINERAL CARBON, WT%	4.41	5.16
ORGANIC CARBON, WT%	18.03	5.51
TOTAL HYDROGEN, WT%	2.43	0.49
TOTAL NITROGEN, WT%	0.73	0.55
TOTAL SULFUR, WT%	1.07	0.80
PYRITIC SULFUR, WT%	0.63	0.31
ORGANIC SULFUR, WT%	0.40	0.16
SULFATE SULFUR, WT%	0.04	0.15
SULFIDE SULFUR, WT%	-	0.18

reducing atmosphere

13 Samples

Average values - not mean

7/13/84 KRC

AGR SPENT SHALE
SPENT SHALE DISPOSAL TESTWORK

A. CONTRACTOR: IN-SITU, INC.

B. PURPOSE: TO DEVELOP AN OVERALL PLAN FOR SPENT SHALE DISPOSAL THAT WILL ADDRESS A VARIETY OF GEOTECHNICAL, HYDROLOGICAL, AND ENVIRONMENTAL CONSIDERATIONS.

C. SCOPE OF WORK:

1. PHYSICAL CHARACTERIZATION OF SPENT SHALE DERIVED FROM RETORTING OF C-B TRACT SHALE IN UNISHALE B RETORT
2. LEACHATE CONTENT CONSIDERATIONS
3. WATER QUALITY IMPACT ANALYSIS
4. CLIMATOLOGY
5. RETORTED SHALE PILE GEOMETRY
6. AGRONOMIC PROPERTIES
7. RETORTED SHALE PILE WATER BALANCE MODELING

* 8. Gaseous generations

7/13/84 KRC

AGR SPENT SHALE PILE DESIGN

PILE DESIGN WILL CONSIST OF:

- A FOUNDATION LAYER OF COARSE ROCK IN SOME AREAS
- THREE ZONES OF PROCESSED SHALE (ZONES I, II, & III)
- COVERING CALLED THE RECLAMATION ZONE

7/13/84 KRC

AGR SPENT SHALE PILE DESIGN

PROCESSED SHALE ZONES

ZONE I (not needed over bedrock) Three ~~FIVE~~ TO TEN FT THICK COMPACTED LAYER BENEATH PORTIONS OF AND OVER THE ZONES II AND III MATERIALS, AND COMPACTED TO 100% MAXIMUM DENSITY OF 92 LB/FT^3 AT OPTIMUM MOISTURE FOR COMPACTION (22 W%).

ZONE II NO ADDITIONAL MOISTURE OR COMPACTION REQUIRED.
70% of matl.

ZONE III COMPACTED BY CONSTRUCTION EQUIPMENT ONLY AS NEEDED TO FACILITATE CONSTRUCTION OF ZONE I FACE LINER.

7/13/84 KRC

AGR SPENT SHALE PILE DESIGN

KEY FEATURES OF SPENT SHALE PILE DESIGN

- ZONE I LAYER OVER ZONE II MATERIAL AND BENEATH RECLAMATION ZONE WILL ACT AS AN AQUITARD UNTIL RECLAMATION ZONE IS ESTABLISHED.

7/13/84 KRC

AGR SPENT SHALE PILE DESIGN

KEY FEATURES OF SPENT SHALE PILE DESIGN

- UPPER ZONE I LAYER IS TO SERVE AS AN AQUITARD BOTH DURING CONSTRUCTION AND AFTER RECLAMATION.

  A. PRIOR TO OR DURING PLACEMENT OF RECLAMATION MATERIAL, ZONE I LAYER WILL SERVE AS A RELATIVELY IMPERMEABLE BARRIER TO MOST PRECIPITATION EVENTS AND DIVERT MOISTURE TO RETENTION FACILITIES.

  B. AFTER RECLAMATION, ZONE I LAYER WILL HELP TO HOLD WATER WITHIN RECLAMATION ZONE -- ENHANCE EVAPOTRANSPIRATION AND REDUCE MOISTURE MOVEMENT THROUGH PILE.

7/13/84 KRC

AGR SPENT SHALE PILE DESIGN

CONCERNS

- CONSOLIDATION OF NATURAL SOILS BENEATH SPENT SHALE PILE
- SPENT SHALE PILE SETTLEMENT
- SPENT SHALE PILE SURFACE WATER CONTROL

8/1/84 KRC

AGR SPENT SHALE PILE DESIGN

CONSOLIDATION OF NATURAL SOILS WILL DEPEND UPON:

- APPLIED LOADS (PILE HEIGHT)
- SOIL/MOISTURE CONDITIONS INCLUDING HORIZONTAL AND VERTICAL VARIATIONS IN SOIL PROFILE
- DEPTH TO BEDROCK

7/13/84 KRC
8/9/84 (REV.1)

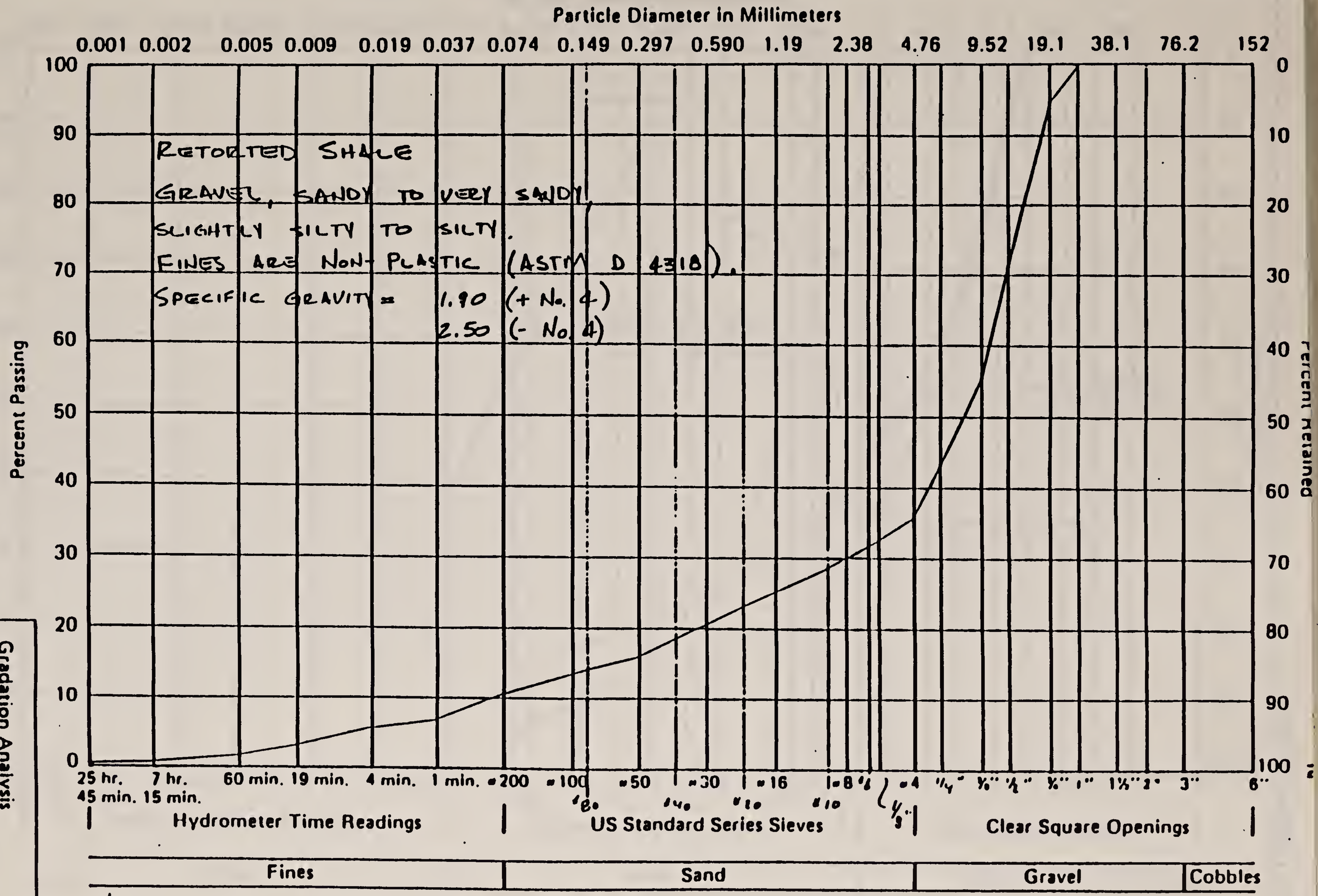
AGR SPENT SHALE PILE DESIGN

SPENT SHALE PILE SETTLEMENT DEPENDS UPON:

- GRADATION OF MATERIALS
- STRENGTH OF INDIVIDUAL AND GROUP OF PARTICLES
- * PILE HEIGHT
- MOISTURE CONDITIONS
- PLACEMENT METHODS
- RESULTANT INITIAL PLACEMENT DENSITIES

7/13/84 KRC

SPENT SHALE GRADATION ANALYSIS



RETORTED SHALE

GRAVEL, SANDY TO VERY SANDY,

SLIGHTLY SILTY TO SILTY.

FINES ARE NON-PLASTIC (ASTM D 4318).

SPECIFIC GRAVITY = 1.90 (+ No. 4)

2.50 (- No. 4)

NOTE: THE SAMPLE WAS CLASSIFIED IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487).

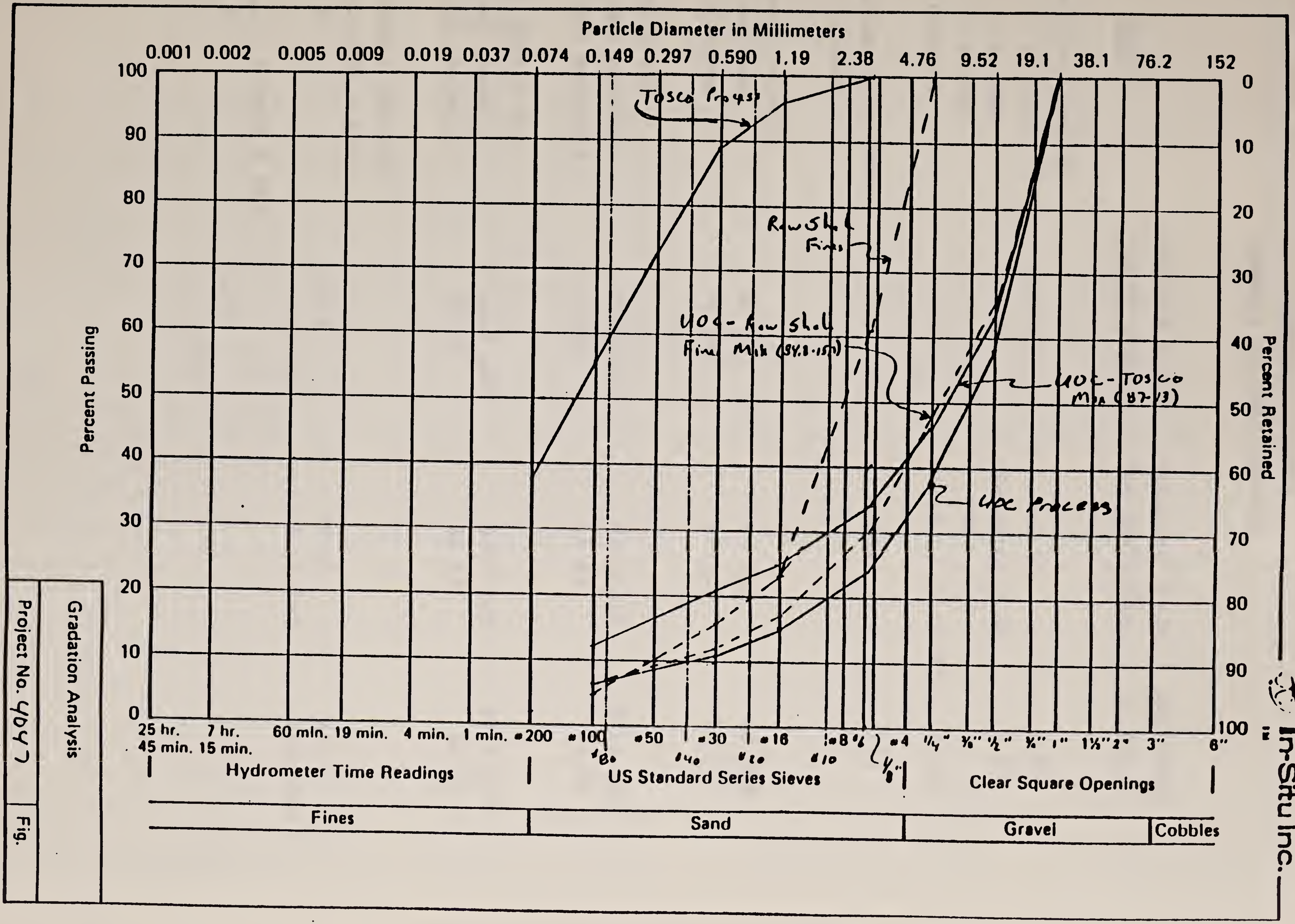
Gradation Analysis
PART A

Project No. 4067

Fig.

FIG 1

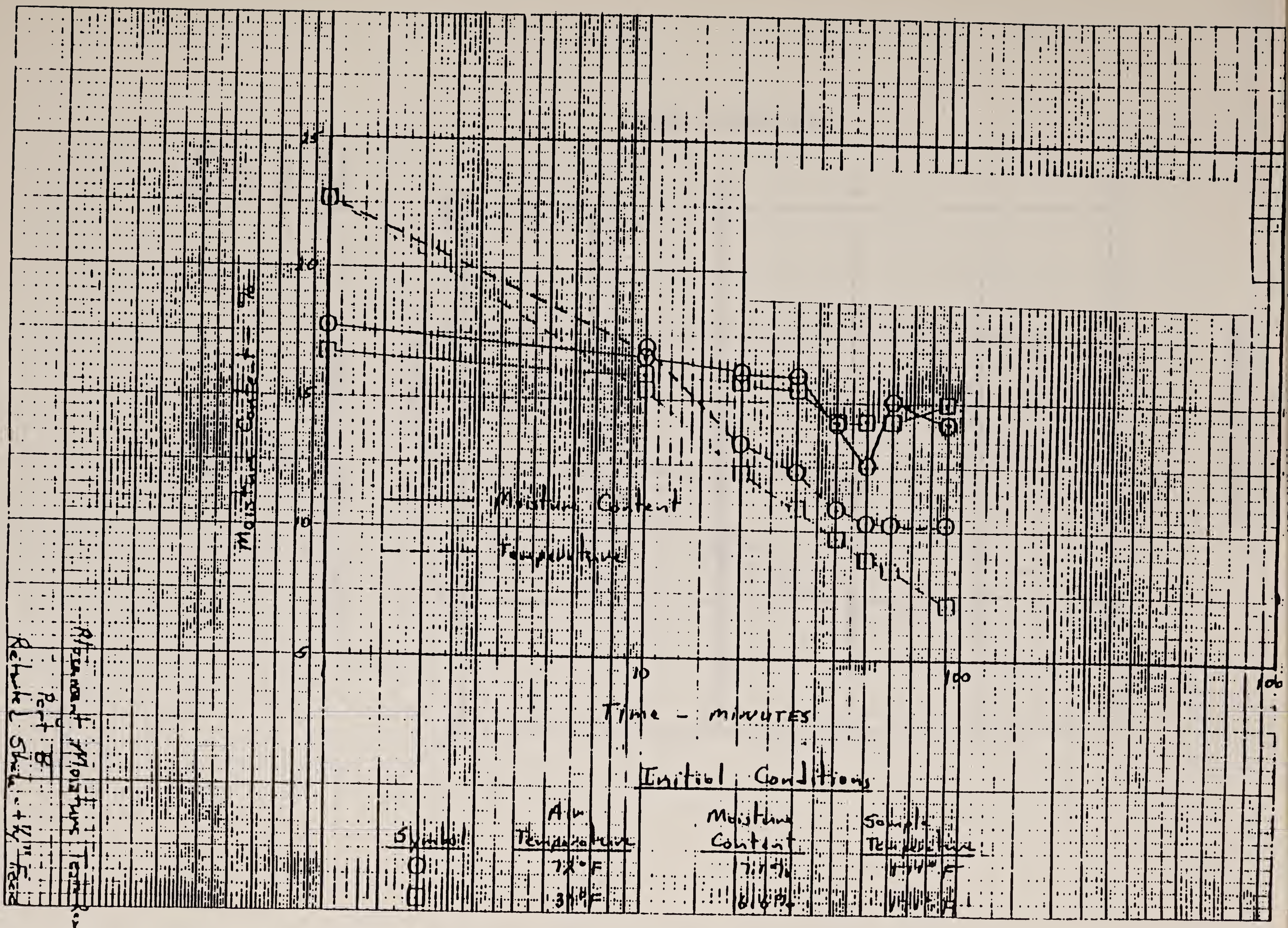
GRADATION COMPARISON



CATHEDRAL BLUFFS
SUMMARY OF TEST RESULTS

Item	Retorted Shale (+1/4" Feed)	Retorted Shale Raw Shale Mix	UOC-TOSCO Mix
Specific Gravity			
+1/4 inch	1.90	1.90	1.90
-1/4 inch	2.50	Retorted 2.50	2.50
-1/4 inch		Raw 1.93	
Overall	2.07	2.10 (2.31 -1/4")	2.18
Placement Moisture Content	13%	15%	14%
Poured Density			
Maximum	65 pcf	69 pcf	65 pcf
Minimum	55 pcf	56 pcf	55 pcf
ASTM D 698			
Opt Density	91.9 pcf	93.4 pcf	93.3 pcf
Opt Moisture	21.5%	18.9%	18.6%
1/2 ASTM D 698			
Opt Density	88.6 pcf	89.9 pcf	89.0 pcf
Opt Moisture	20.7%	20.3%	22.4%
Triaxial Strength			
(at ASTM D 698)			
Ø	29.5°	30.5°	26.5°
c	0.97 ksf	0.85 ksf	1.05 ksf
(at 1/2 ASTM D 698)			
Ø	17°		
c	1.4 ksf		

PLACEMENT MOISTURE TESTWORK



Placement Moisture Test Result
Part B
Retorted Shale + 1/4" Feed

Project No. 4047 Fig. 7

POURING TESTWORK

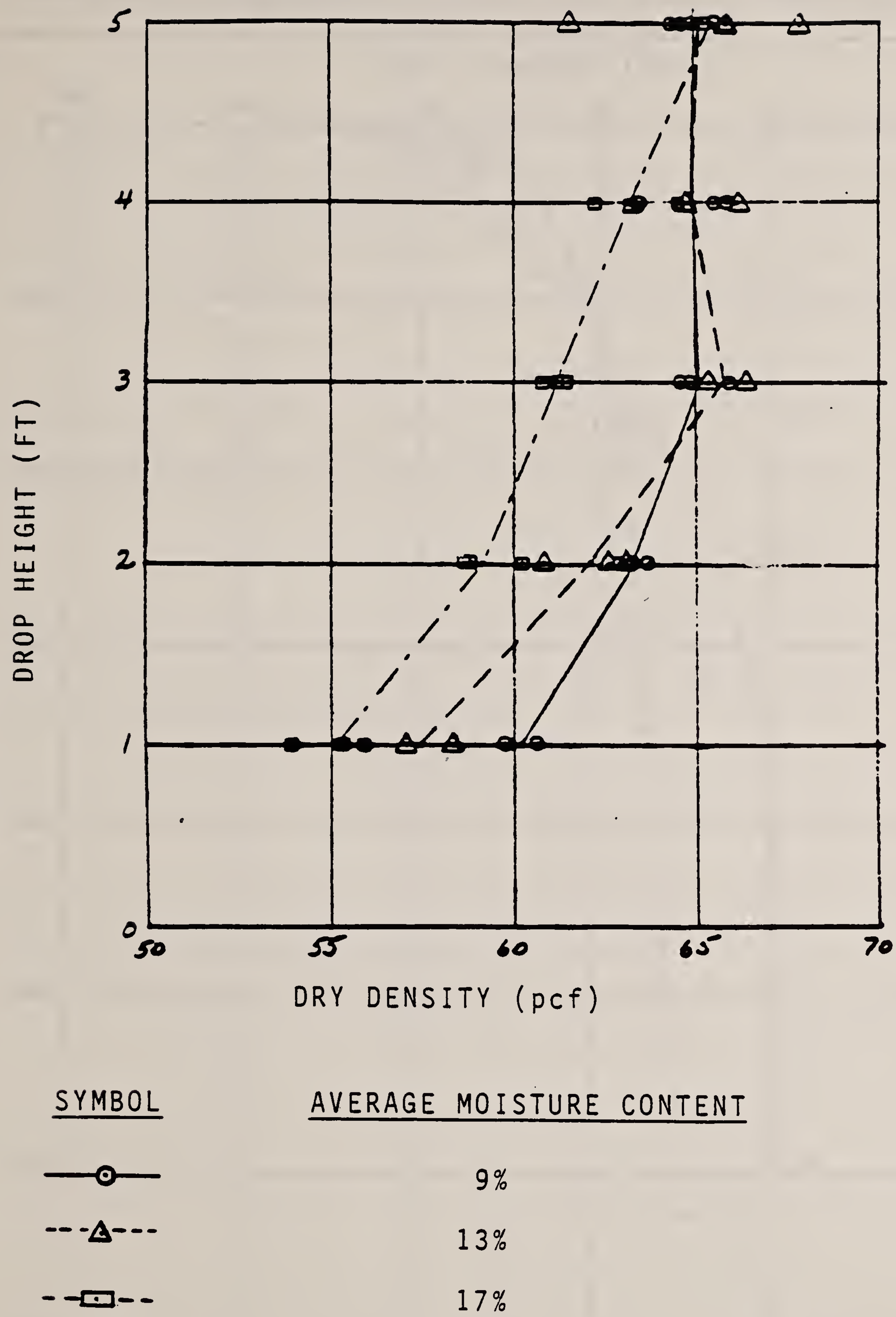


FIGURE 5

[illegible]

[illegible]

[illegible]

PILE DENSITY

In·situ Inc.

Data and Work

Page 3

Project C-B PART E

Date 5-23-84

Experiment COMPRESSION (+ 1/4" FEED)

Charge No. 4-017

Investigator K. AUBRY

Reference No.

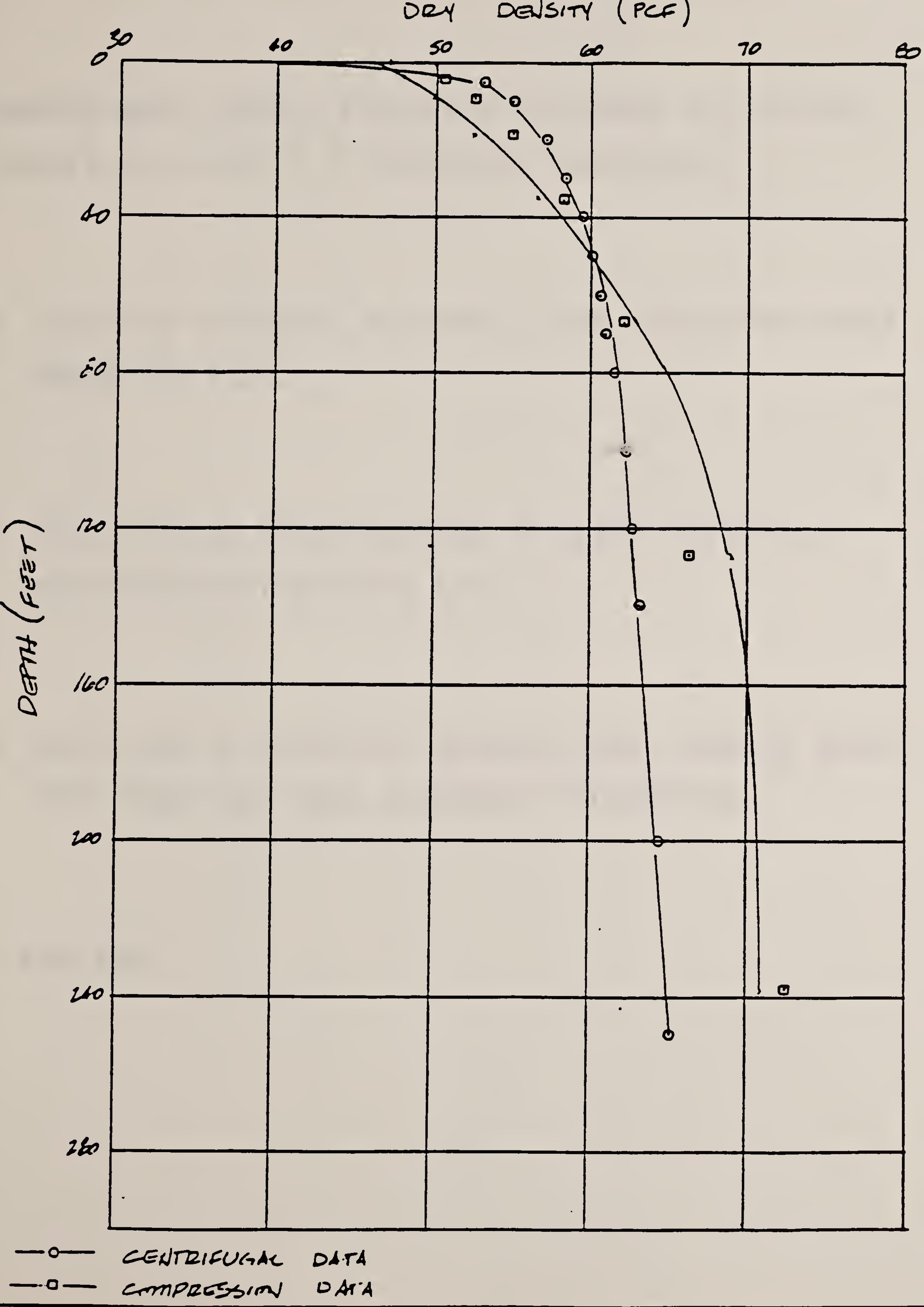


FIG. 11

SPENT SHALE PILE SURFACE WATER CONTROL

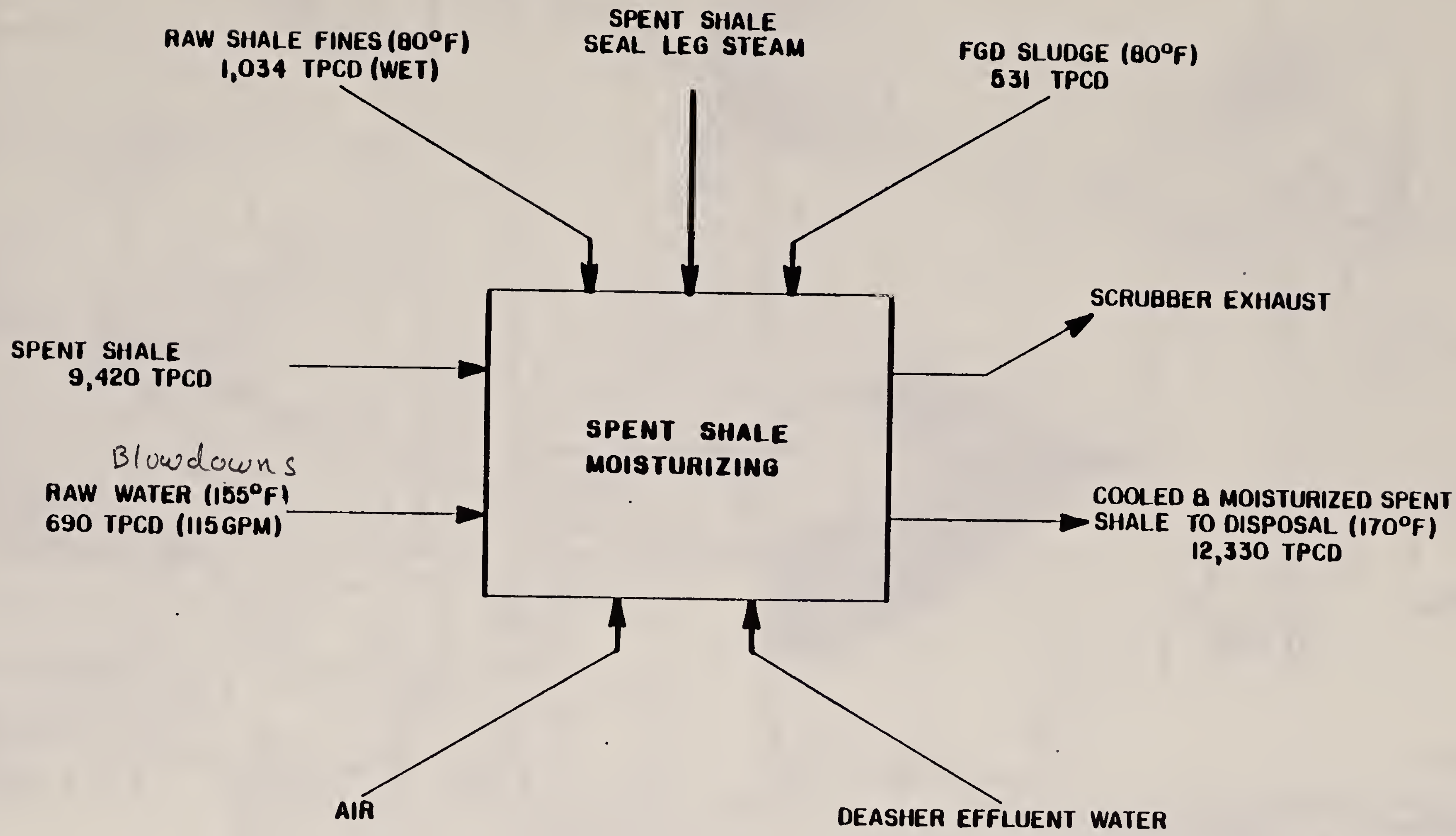
SURFACE WATER CONTROL SYSTEM FOR COTTONWOOD AND SORGHUM GULCHES WILL CONSIST OF THREE BASIC COMPONENTS:

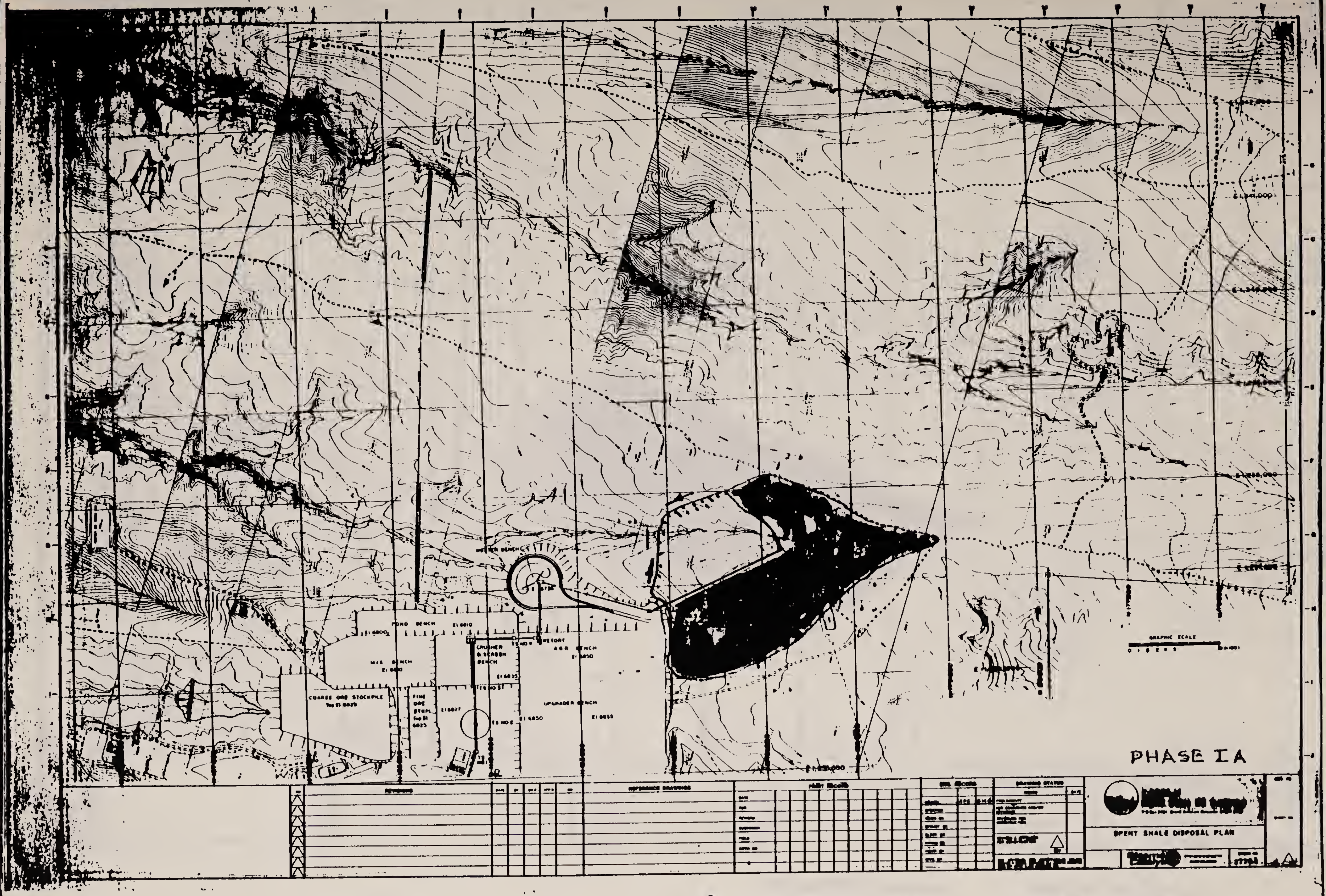
- DIVERSION OF RUNOFF IN CHANNELS FROM UNDISTURBED AREAS AROUND THE PILE.
- COLLECTION IN RETENTION PONDS OF RUNOFF POTENTIALLY CONTAMINATED BY RETORTED SHALE.
- COLLECTION IN DETENTION (SEDIMENTATION) PONDS OF RUNOFF FROM THOSE PILE AREAS UNDERGOING RECLAMATION.

8/1/84 KRC

SPENT SHALE MOISTURIZING

BLOCK FLOW DIAGRAM

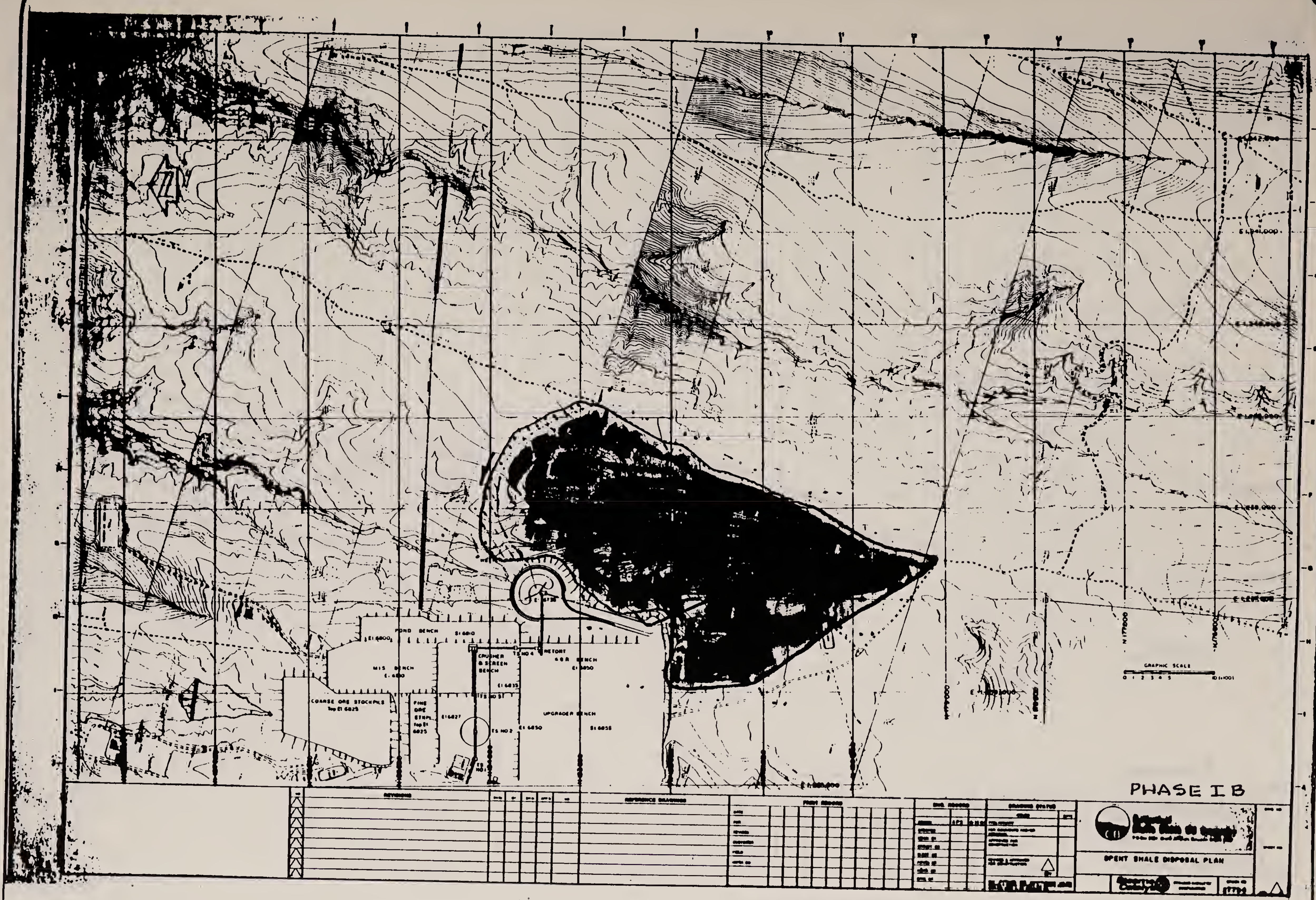




· · CLEAN RUNOFF
→ CONTAMINATED RUNOFF

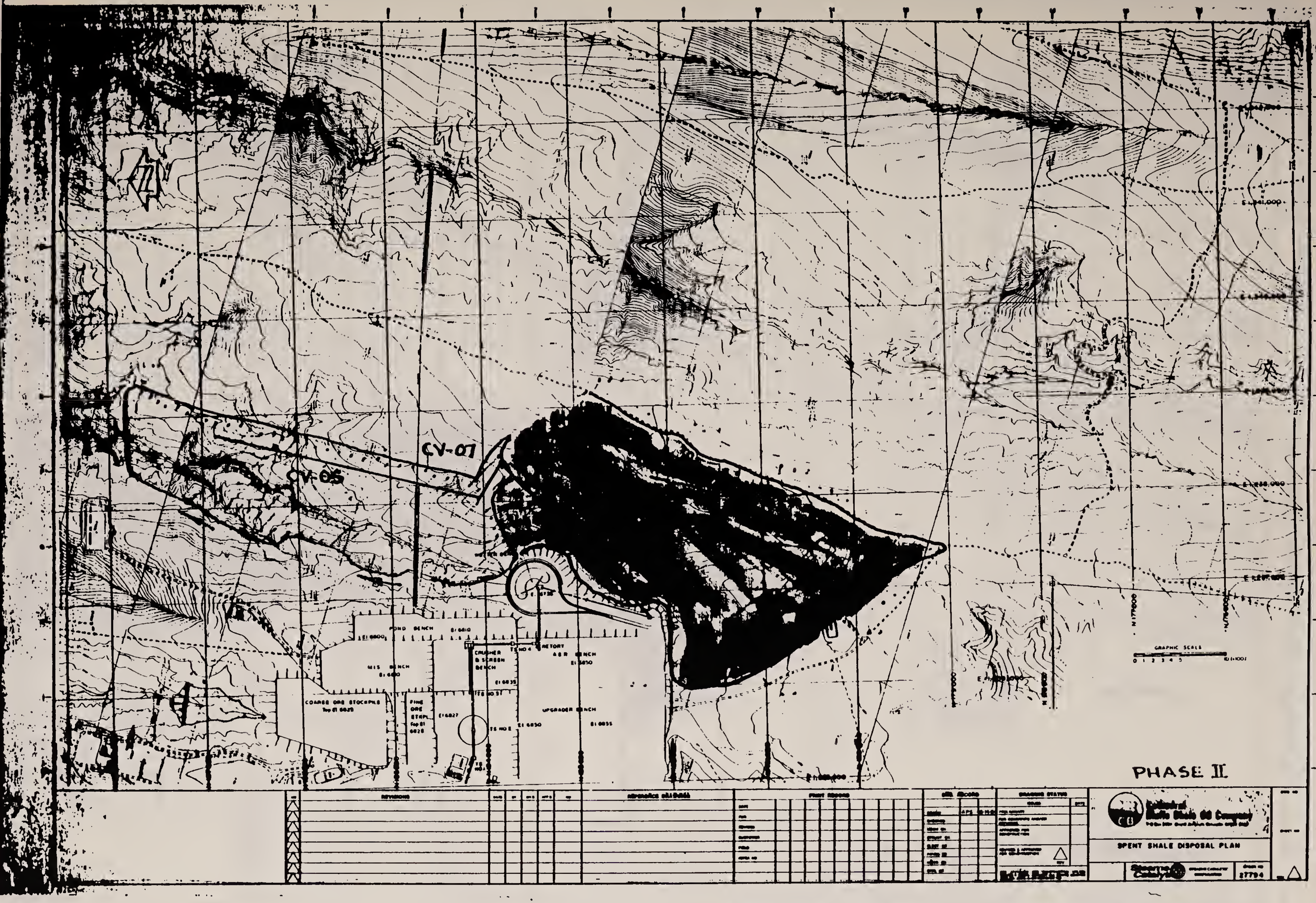
■ RECLAIMED 69 Acres
▨ UNRECLAIMED 27 Acres

VOLUME 6.3 MM Tons
TIME 2.5 Years



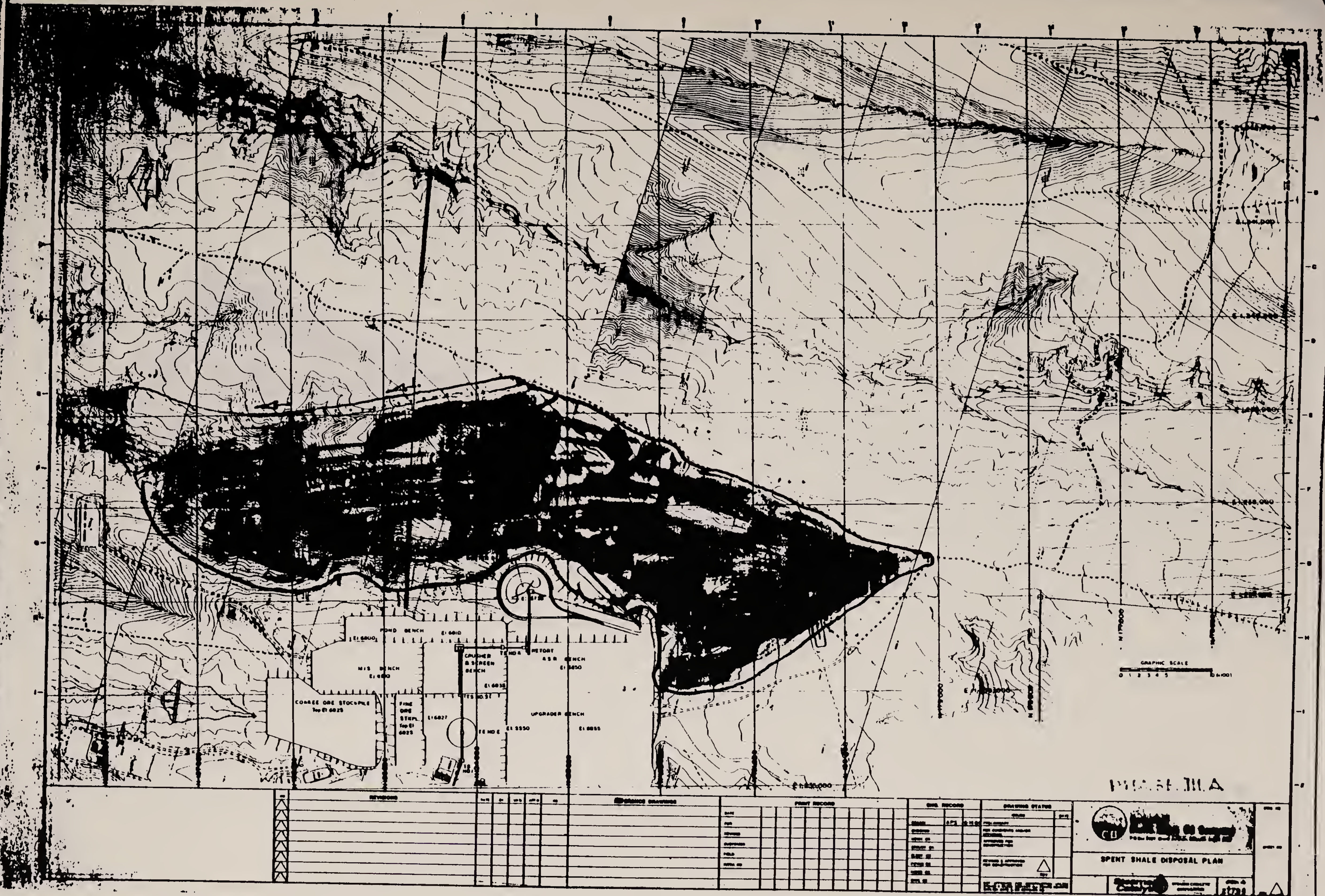
RECLAIMED 184 Acres
UNRECLAIMED 5 Acres

VOLUME 15.3MM Tons
TIME 5 Years



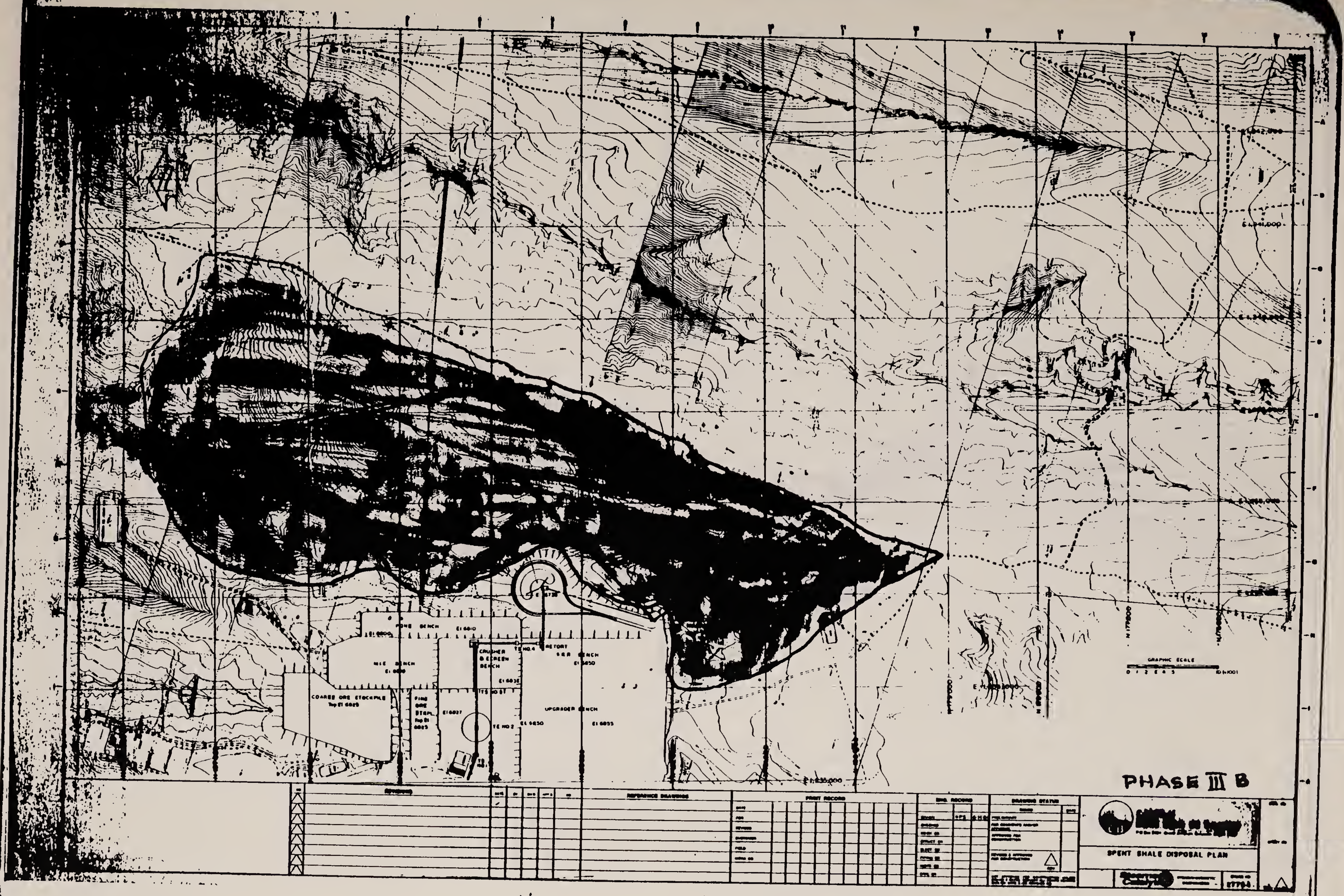
RECLAIMED 192 Acres
UNRECLAIMED 104 Acres

VOLUME 20.4 MM Tons
TIME 6.5 Years



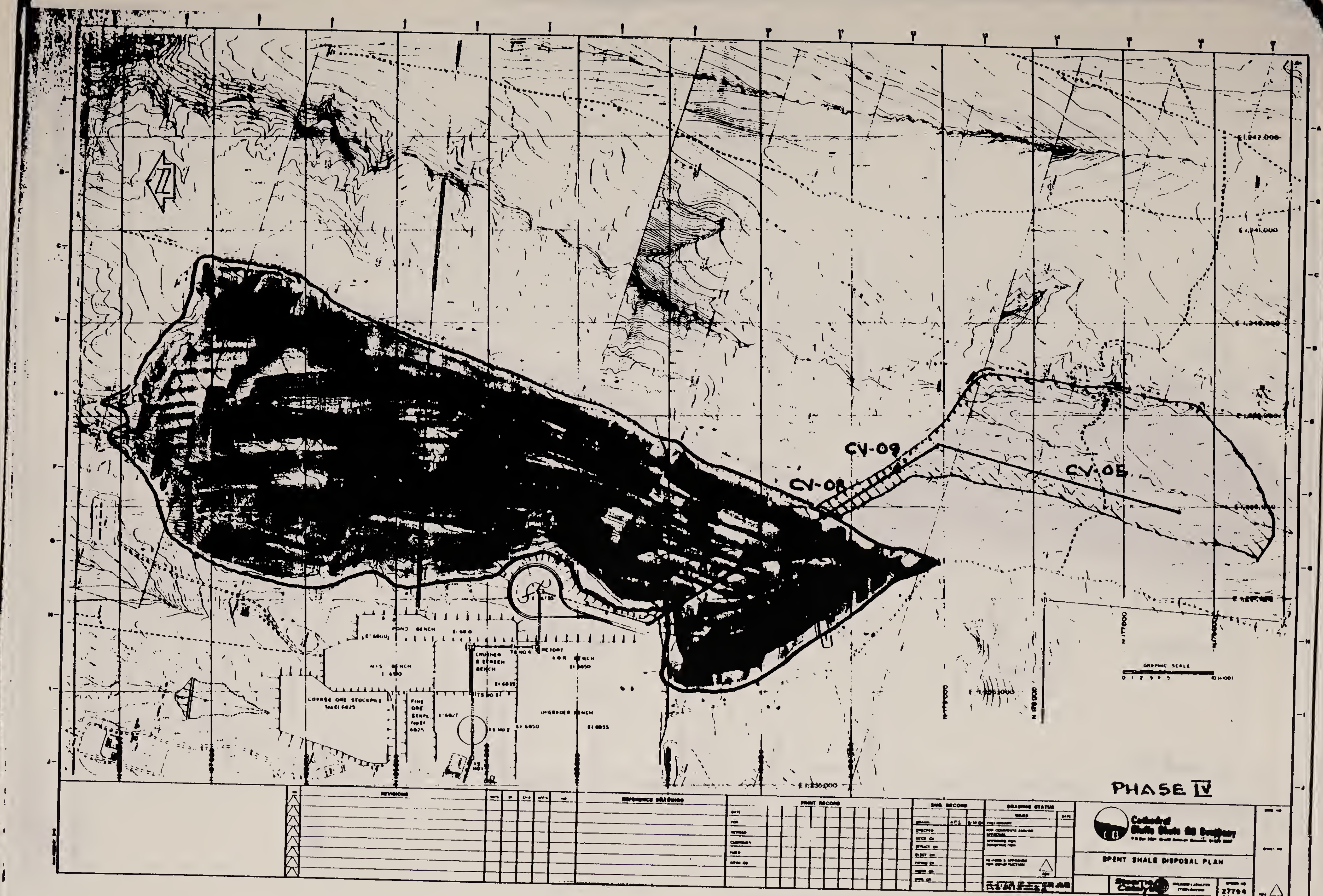
RECLAIMED 342 Acres
UNRECLAIMED 18 Acres

VOLUME 39 MM Tons
TIME 12 Years



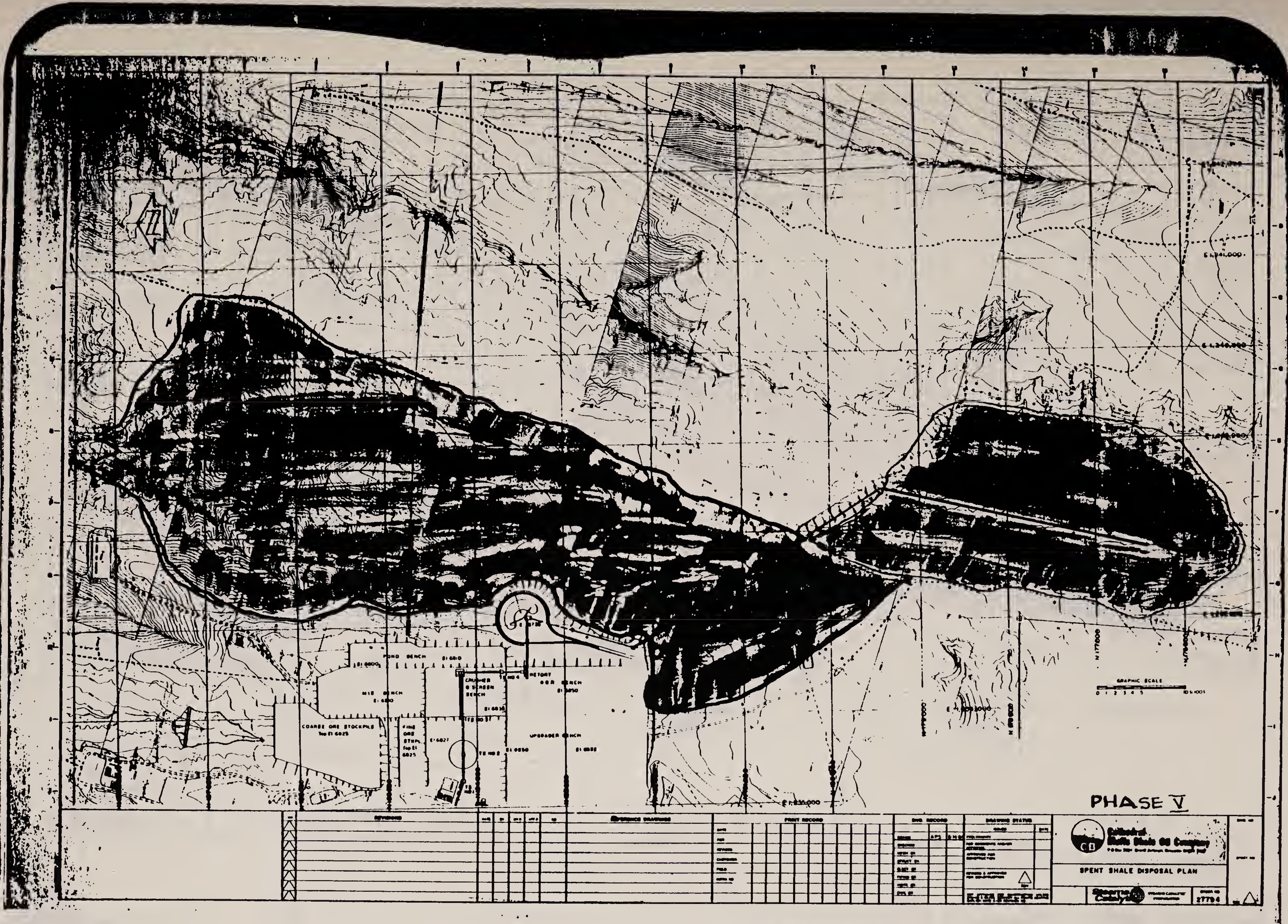
RECLAIMED 456 Acres
UNRECLAIMED - Acres

VOLUME 49.4 MM Tons
TIME 15 Years

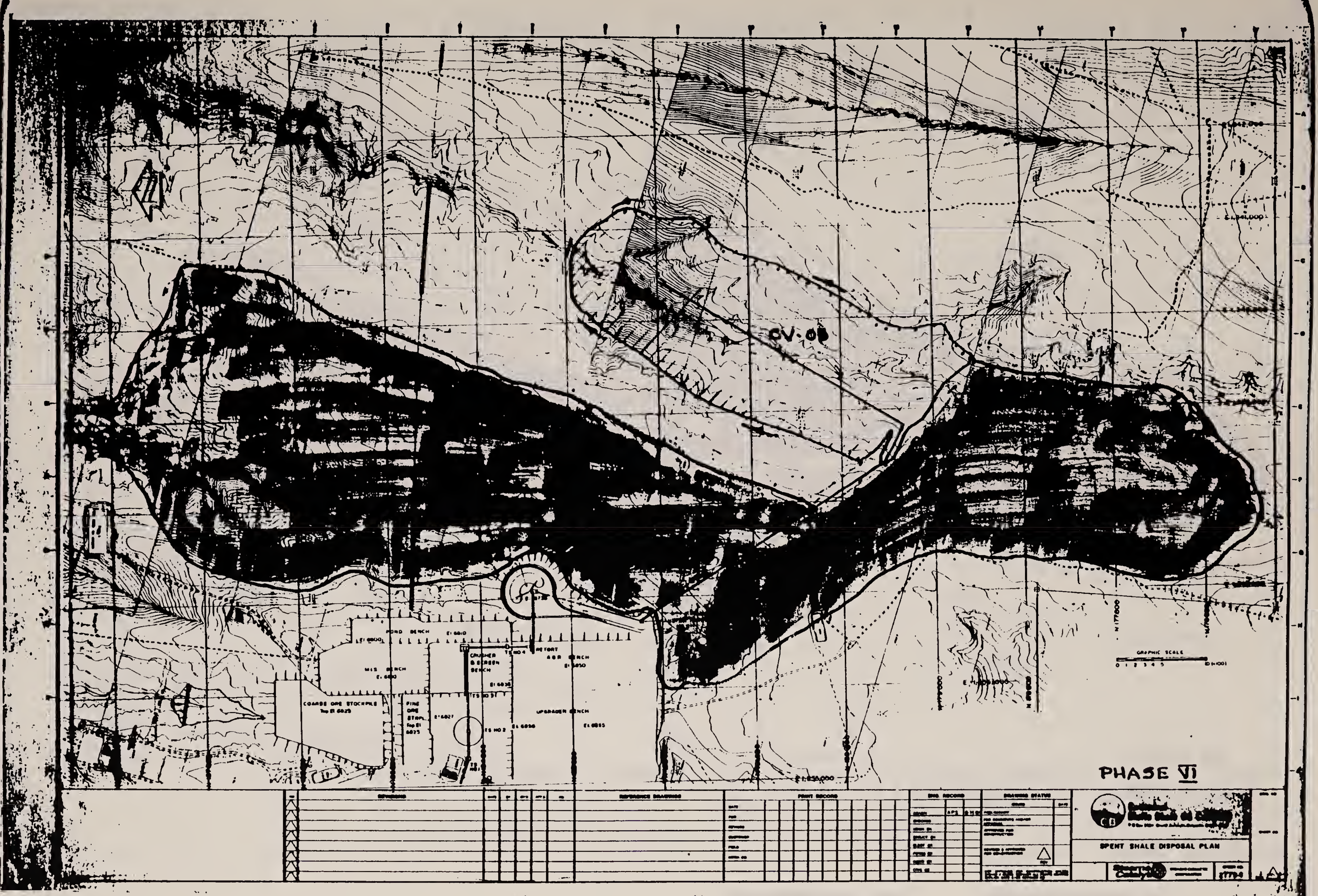


RECLAIMED 456 Acres
UNRECLAIMED 112 Acres

VOLUME 564 MM Tons
TIME 17 Years

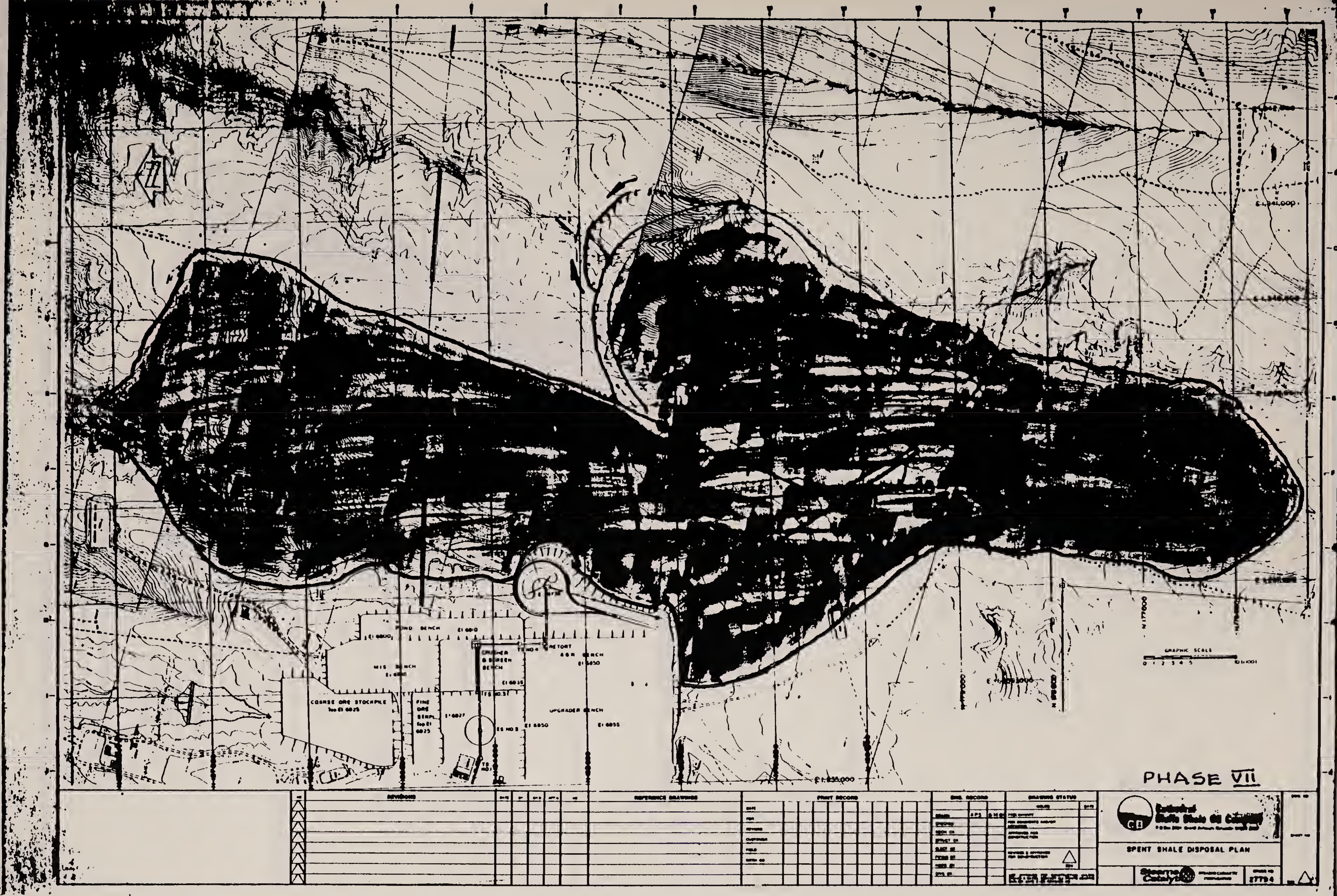


REGLAIMED 632 Acres VOLUME 67.4 MM Tons
UNRECLAIMED 3 Acres TIME 20 Years



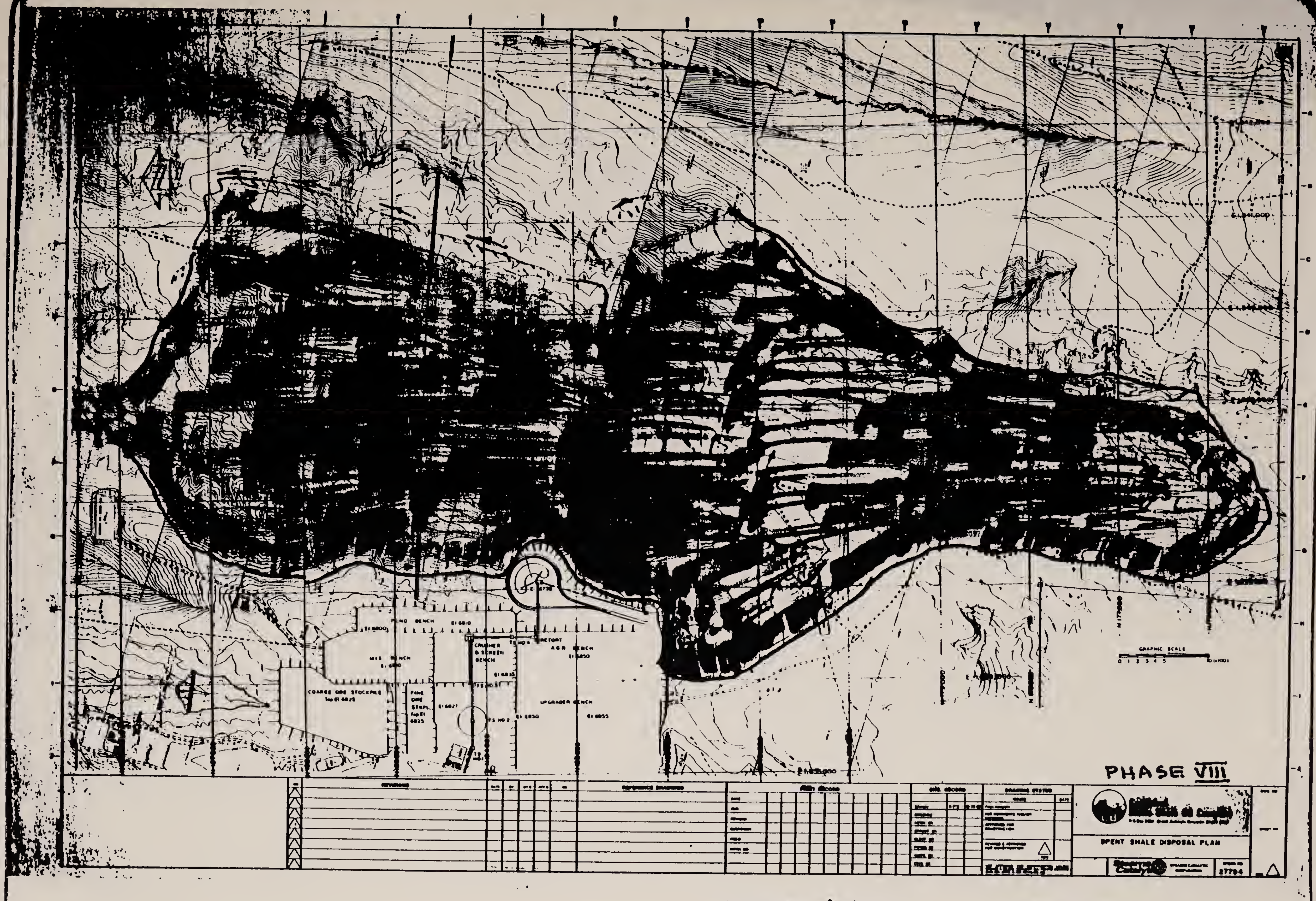
RECLAIMED 632 Acres
UNRECLAIMED 128 Acres

VOLUME 76.4 MM Tons
TIME 22.5 Years



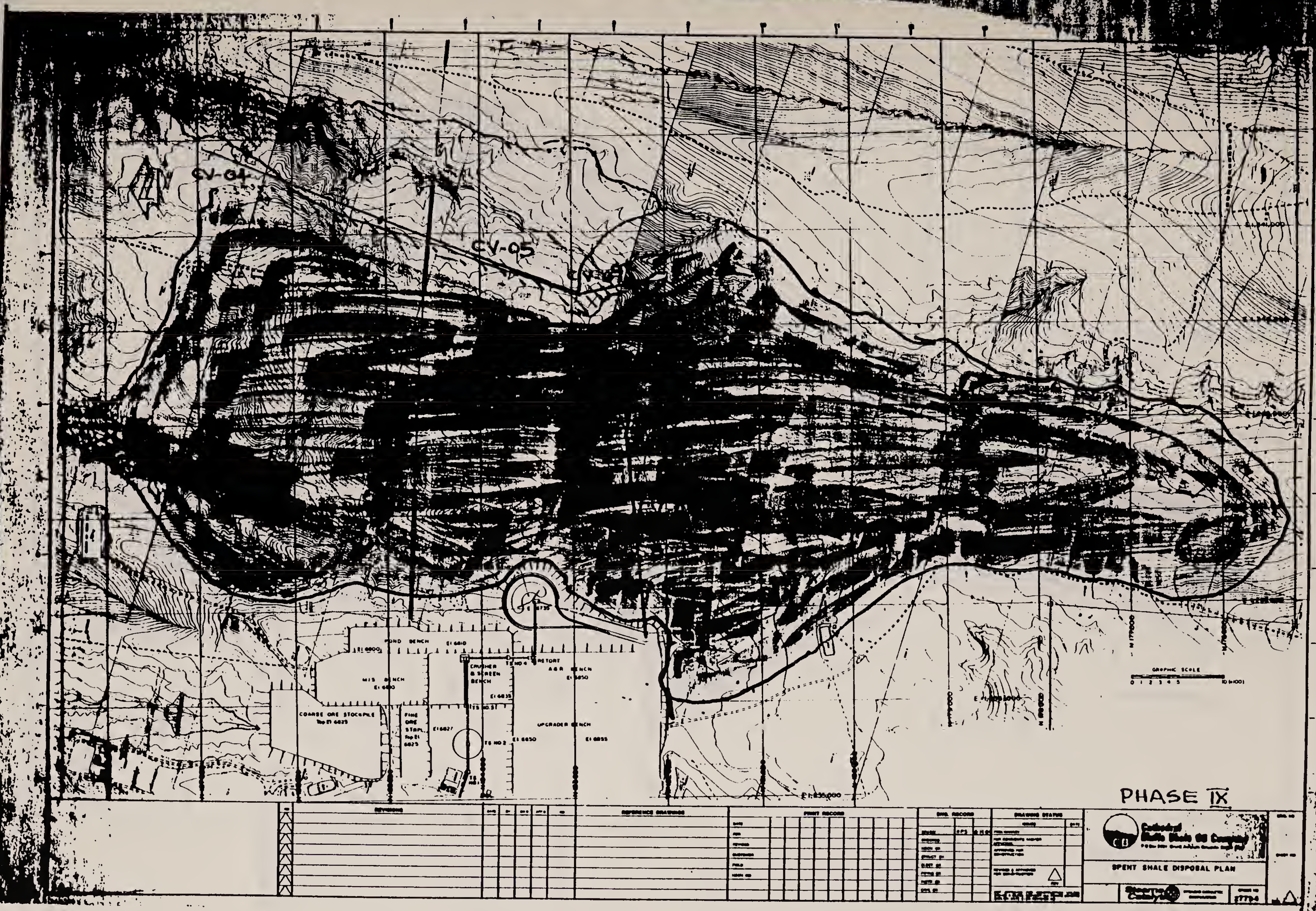
RECLAIMED 801 Acres
UNRECLAIMED 10 Acres

VOLUME 97.5 MM Tons
TIME 28.5 Years



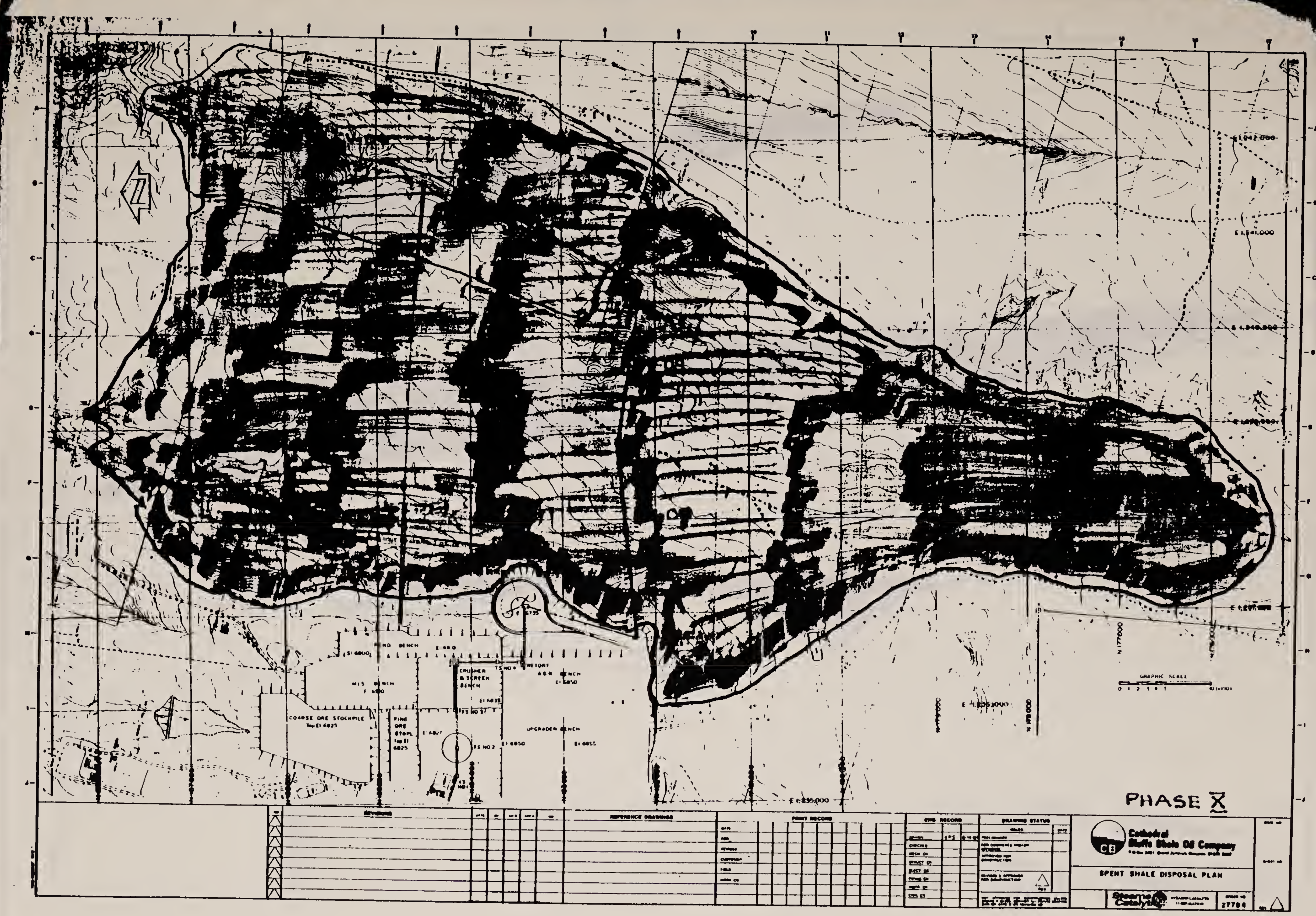
RECLAIMED 898 Acres
UNRECLAIMED 26 Acres

VOLUME 110.3 MM Tons
TIME 32 Years



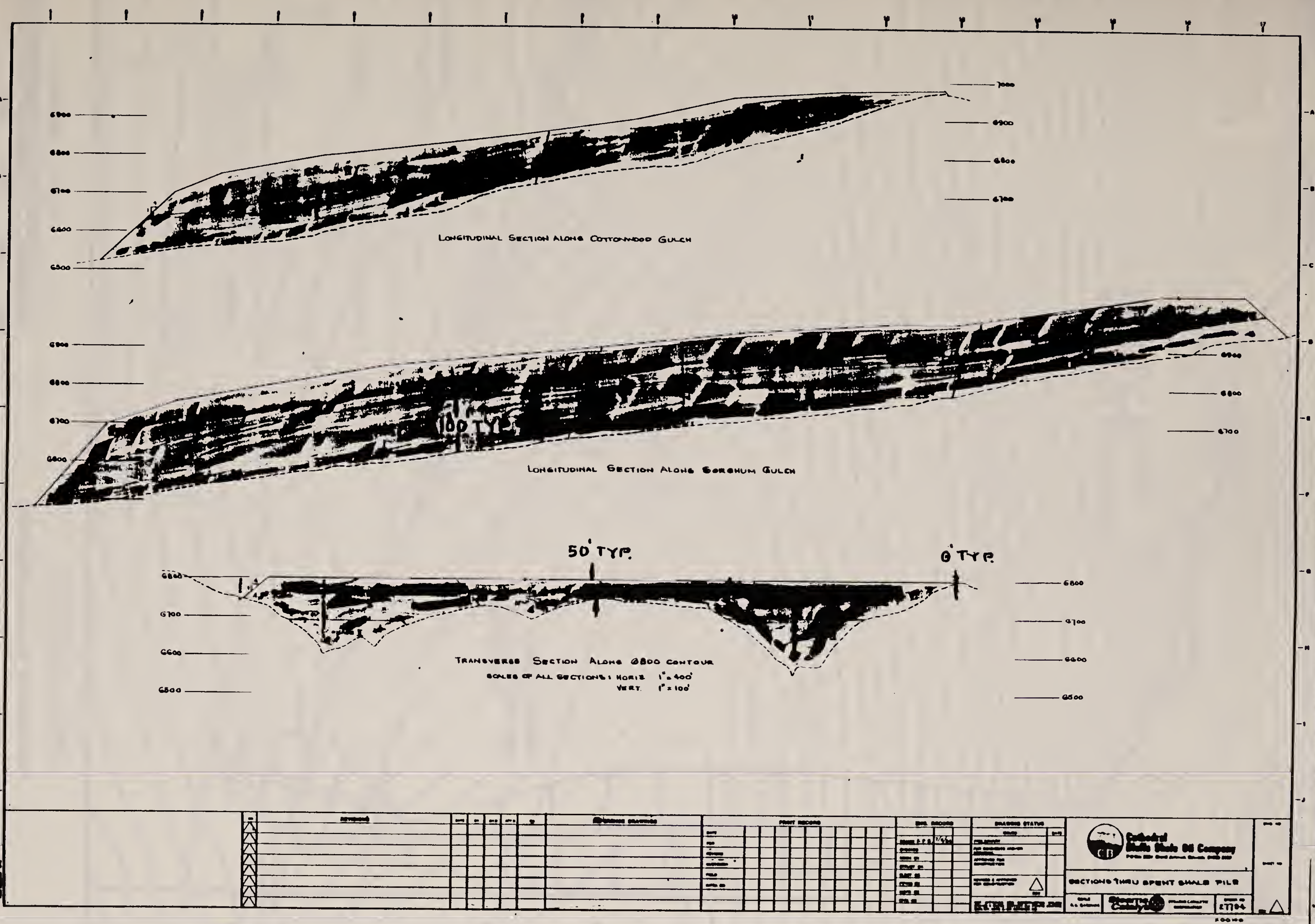
RECLAIMED 898 Acres
UNRECLAIMED 152 Acres

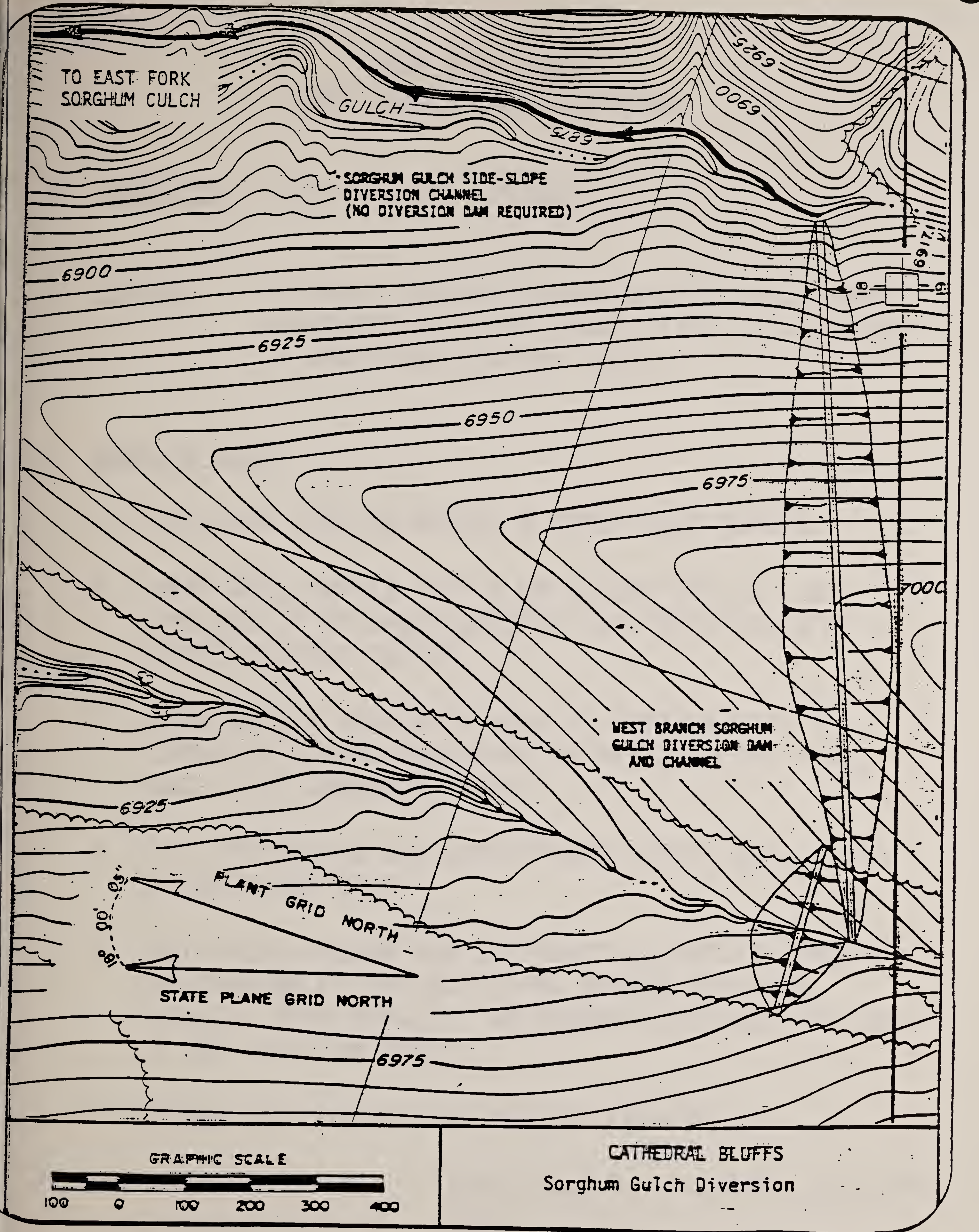
VOLUME 121.2 MM Tons
TIME 35 Years



RECLAIMED 112.1 Acres
UNRECLAIMED 0 Acres

VOLUME 146 MM Tons
TIME 42 Years


7000
6900
6800
6700
6600
6500
LONGITUDINAL SECTION ALONG COTTONWOOD GULCH
100' TYP.
LONGITUDINAL SECTION ALONG SORGHUM GULCH
50' TYP.
0' TYP.
TRANSVERSE SECTION ALONG 6800 CONTOUR
SCALES OF ALL SECTIONS: HORIZ. 1" = 400'
VERT. 1" = 100'
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
DRAWING STATUS
Cathedral Bluffs Shale Oil Company
SECTIONS THRU SPENT SHALE PILE



CATHEDRAL BLUFFS
Sorghum Gulch Diversion

AGR SPENT SHALE
SPENT SHALE LEACHATE TESTWORK

A. CONTRACTOR: COLORADO STATE UNIVERSITY

B. PURPOSE: TO OBTAIN DATA ON LEACHATE QUALITY AND DETERMINE PERMEABILITY OF SPENT SHALE TO AID IN EVALUATION OF SPENT SHALE DISPOSAL DESIGN.

C. SCOPE OF WORK:

1. ESM COLUMN TESTS ON VARIETY OF SPENT SHALE SAMPLES.
2. SPENT SHALE SAMPLES USED IN ESM COLUMN TESTS WILL BE COMPACTED TO DIFFERENT DENSITIES AND MOISTURIZED WITH DESIRED MOISTURE CONTENT.
3. WATER USED IN THESE TESTS WOULD BE REPRESENTATIVE OF MIXTURE OF STREAMS (RAW PLANT AND PROCESS WATER) TO BE USED IN THE COMMERCIAL PLANT.
4. BOTH STRIPPED AND UNSTRIPPED PROCESS WATERS SHALL BE USED IN ESM COLUMN TESTS.
5. OTHER TESTS INCLUDE SIZE DISTRIBUTION, PARTICLE DENSITY AND PERMEABILITY DETERMINATIONS, MAXIMUM RETENTION CAPACITY, FIELD CAPACITY, AND WILTING COEFFICIENT FOR EACH OF THE TWO COLUMN TESTS.
6. ORGANIC AND INORGANIC ANALYSES OF LEACHATES.

7/13/84 KRC

Tests complete - no data available yet.

MODIFIED INSITU PROCESSING (MIS)

Mineralogy
Design Basis
Start Up
Steady State
Quenching and Shutdown

MIS PROCESSING DETAILS

(300 ' MIS Zone - Mahogany/R-6 Zones)*

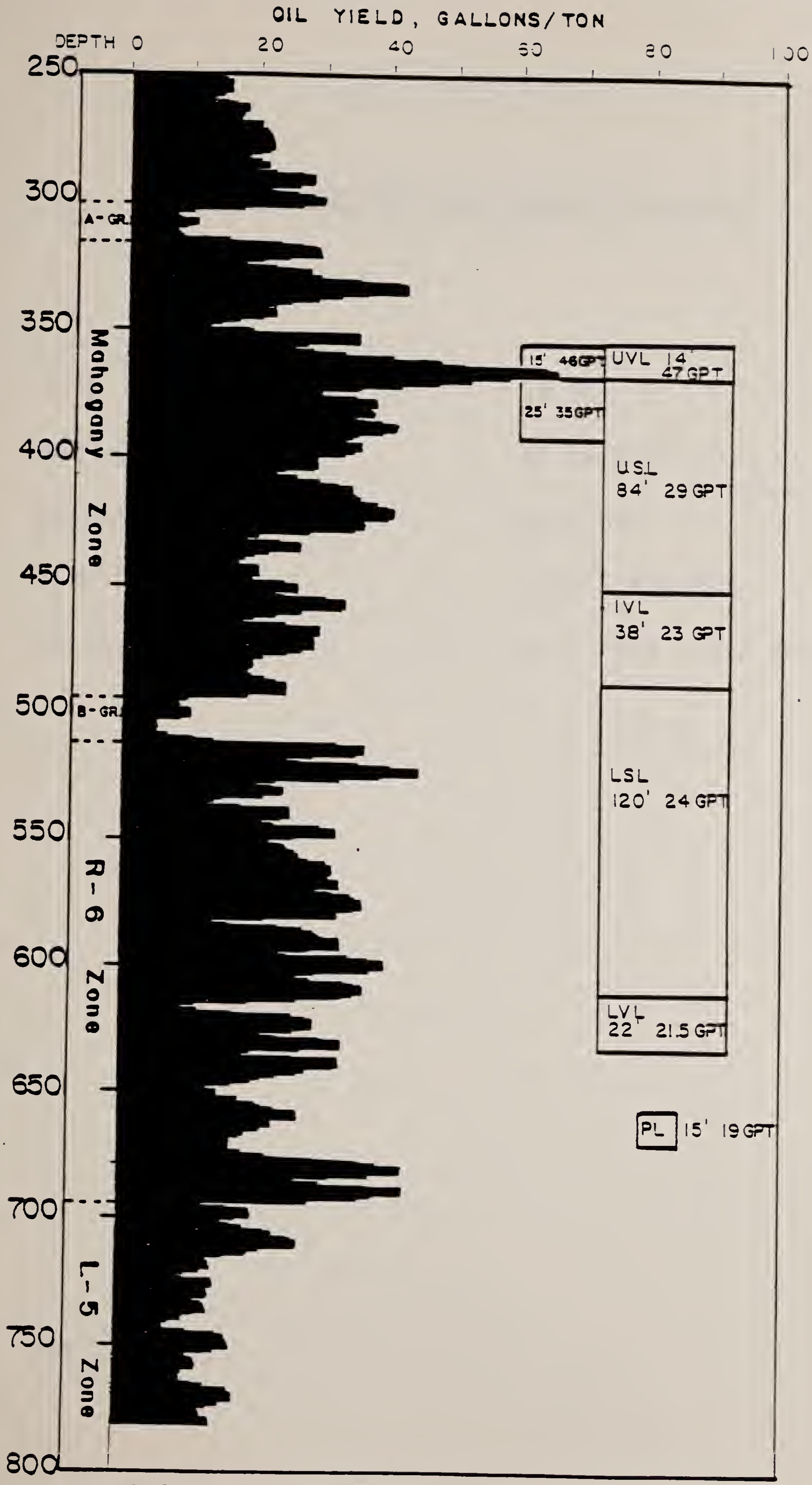
MINERALOGY	PEAK HEIGHTS			EST. WT. %		
	MZ	R-6Z	Avg. MIS Int.	MZ	R-6	MIS
DOLOMITE	86	98	91	25%	29%	27%
QUARTZ	72	36	57	9%	5%	7.5%
DAWSONITE	7.8	ND	4.5	1.6%	-	1.3%**
CALCITE	31	13	23	5%	2%	3.5%
ANALCITE	TR	TR	TR	-	-	-
NA-FELDSPAR	38	60	48	-	-	-
K-FELDSPAR	17	27	21	-	-	-
PYRITE	3	6	4.5	<1%	1%	<1%
MG-SIDERTIE	7	7	7	-	-	-
ARAGONITE	5	ND	3	-	-	-
NAHCOLITE	ND	ND	-	-	-	-
ILLITE	2	1	1	-	-	-

* BASED ON ONE CB COREHOLE - TG71-1

** NO DAWSONITE DETECTED IN LOWER MAHOGANY AND R-6 ZONE

JNS/sb 7/12/84

AVG CB COREHOLE



MIS/R&P STATION LAYOUT VS RICHNESS LOG

REQUESTED INFORMATION FROM DESIGN BASIS

VOID VOLUME	18.5%
PARTICLE SIZE	3″ AVERAGE Mass weighted Conv. seive test
AVERAGE GRADE	25.9 GPT
TEMPERATURE	1600°F MAXIMUM
PRESSURE	11.7 PSIA - 9.7 PSIA

7/31/84 WJMB

START-UP PROCEDURE

OBJECTIVE: ESTABLISH UNIFORM COMBUSTION ZONE ACROSS TOP OF RETORT.

PROCEDURE:

- PURGE AIR FROM RETORT RUBBLE VOID WITH INERT GAS INTO OFFGAS DUCTS MAINTAINING LESS THAN 4% OXYGEN IN COMBINED OFFGAS.
- RAPIDLY HEAT TOP SURFACE OF THE RETORT RUBBLE BED, USING HOT INERT GAS, TO COMBUSTION TEMPERATURE OF APPROXIMATELY 750°F.
- INTRODUCE AIR TO INITIATE, ESTABLISH, AND PROPAGATE COMBUSTION ZONE.

INPUTS:

	COMPONENTS
INERT GAS	CO_2, N_2, H_2O
AIR	O_2, N_2

RATES AND COMPOSITION VARY DEPENDING ON STEP OF PROCEDURE.

OUTPUTS:

OFFGAS	CO_2, N_2, H_2O, HC Trace amounts
WATER	H_2O

RATES AND COMPOSITION VARY DEPENDING ON STEP OF PROCEDURE.

7/31/84 WJMB

STEADY STATE PROCEDURE

OBJECTIVE: PRODUCE 2260 BPCD OF RAW SHALE OIL IN A SAFE EFFICIENT MANNER.

PROCEDURE:

- REMOVE BURNER SYSTEM AND INSTALL INLET AIR LINE AND FLOW CONTROL VALVE.
- INTRODUCE AIR AT 12,088 SCFM/RETORT.
- MONITOR BULKHEAD TEMPERATURES.
- CONTROL PRODUCT BULKHEAD TEMPERATURE. Sprays
  Also allows carrying retorting lower into bottom or retort
- CONTROL RETORT PRESSURE BELOW PRESSURE OF MINE.
- MONITOR GAS, OIL, AND WATER PRODUCTION.
- CONTROL OIL/WATER LEVEL BEHIND PRODUCT BULKHEAD.
- COMPLETION OF RETORTING DICTATED WHEN THE O_2 IN OFFGAS EXCEEDS 2%, OUTLET TEMPERATURE EXCEEDING 200°F OR OIL PRODUCTION CEASES.

INPUTS:

- AIR AT 12,088 SCFM/RETORT

OUTPUTS:

- WATER - RATE VARIES DURING RUN (NET 0)
- OFFGAS - 168.6 MMSCFD (TOTAL OF FOUR ACTIVE RETORTS, FOUR QUENCHING)
- BULKHEAD OIL - 1667 BPSD (TOTAL OF FOUR ACTIVE RETORTS)

7/31/84 WJMB

QUENCH PROCEDURE

OBJECTIVE: REMOVE RESIDUAL HEAT FROM RETORTING TO PREVENT DEGRADATION OF RETORT PILLARS, TREAT PROCESS WATER, AND STRIP HYDROCARBONS FROM SPENT SHALE RUBBLE BED.

PROCEDURE:

- AFTER COMPLETION OF RETORTING, INSTALL FOUR LINES TO TOP OF RUBBLE BED.
- BEGIN WATER INJECTION.
- CEASE WATER INJECTION APPROXIMATELY 10 MONTHS ← Somewhat arbitrary, may change with experience AFTER BEGINNING.

INPUTS:

- WATER - RATE 52/GPM/RETORT

OUTPUTS:

- WATER - VARIES DURING QUENCHING CYCLE ? Quality
- GAS - 300 SCFM/RETORT AVERAGE ? Composition
- OIL - VARIES FROM SMALL AMOUNTS (E.G., 20-30 B/D) AT BEGINNING TO NIL AT END OF QUENCH.

7/31/84 WJMB

SHUTDOWN

OBJECTIVE: MAINTAIN SHUTDOWN RETORTS IN A SAFE, ENVIRONMENTALLY ACCEPTABLE MANNER.

PROCEDURE:

- MONITOR AND REMOVE OIL/WATER LEVEL AT PRODUCT LEVEL BULKHEAD.
- MONITOR BULKHEAD TEMPERATURES.
- MONITOR BULKHEAD PRESSURES. 6-12 was after quenching stops

INPUTS: NONE

OUTPUTS:

- WATER MAKE WILL DECLINE WITH TIME
- GAS MAKE WILL DECLINE WITH TIME

7/31/84 WJMB

MIS POST RETORTING OPERATIONS

CB EXPECTS TO CARRY OUT THE FOLLOWING STUDY PROGRAM DESIGNED TO DETERMINE A COST AND ENVIRONMENTALLY ACCEPTABLE METHOD FOR HANDLING AND ABANDONING MIS RETORTS AT C-B TRACT.

I DATA ANALYSIS AND COMPUTER MODELING.

II PRE-IGNITION MIS RETORT WATER MANAGEMENT.

III POST-IGNITION TESTING (QUENCHING, LEACHING, DATA ANALYSIS, AND MODEL UPDATE).

IV FINAL ABANDONMENT PLAN.

JNS:PH 7/31/84

I. DATA ANALYSIS AND COMPUTER MODELING

1. LOGAN WASH RETORT DATA
   - o QUENCHING
   - o LEACHING

2. CB GROUNDWATER MODELING PROGRAM
   - o FLOW MODEL
   - o SOLUTE TRANSPORT MODEL

3. GROUNDWATER MONITORING PROGRAM

JNS:BG 7/31/84

1. ANALYZE LOGAN WASH MIS RETORT WATER DATA

   A. ANALYTICAL CHARACTERIZATION OF LOGAN WASH SPENT/QUENCHED RETORTS TO ACQUIRE POST-ABANDONMENT TRANSPORT AND LEACH PARAMETERS.

   B. ANALYTICAL (MATHEMATICAL) STUDIES TO MAKE PREDICTIONS.

      o OCCIDENTAL RESEARCH DATA AND STUDIES.

      o CONSULTANTS

   C. LABORATORY PILOT STUDIES, AS NEEDED.

   D. PREDICT CB MIS LEACHATE BY COMPARING CB AND LOGAN WASH MINERALOGY.

   E. PREDICT DISPERSION OF LEACHATE FROM CB MIS RETORTS USING TRANSPORT MODEL.

JNS:BG 7/31/84

2. CB GROUNDWATER MODELING PROGRAM

PURPOSE OF THE PROGRAM

A. TO DEVELOP THE CAPABILITY OF PREDICTING THE EFFECTS OF MINE DEWATERING ON THE GROUNDWATER AND SURFACE WATER SYSTEM IN AND AROUND C-B. Model up & running by 1985

B. TO USE THE PREDICTIVE CAPABILITY OF THE MODEL AT COURT HEARINGS IN 1985 WHEN CB'S WATER AUGMENTATION PLAN IS REVIEWED FOR APPROVAL.

C. TO PREDICT EFFECTS OF C-B TRACT AND OTHER MINING PROJECTS ON WATER RESOURCES IN PICEANCE BASIN.

D. TO REDUCE LONG-TERM MONITORING AND TESTING COSTS BY USING THE MODEL TO PREDICT AFFECTED AND NON-AFFECTED AREAS; THUS, TESTING AND MONITORING ONLY AS NEEDED.

E. DEVELOP THE CAPABILITY OF PREDICTING INFLOWS INTO A CB MINE (CB SUPPLY).

F. DEVELOP THE CAPABILITY OF PREDICTING EFFECTS OF MIS SPENT RETORT LEACHATE ON THE GROUNDWATER SYSTEM (TRANSPORT MODEL).

JNS:PH 7/31/84

FLOW MODEL

1. ADAPT THE USGS THREE-DIMENSIONAL MATHEMATICAL MODEL TO C-B TRACT.
    - A) PERFORM TEST RUNS USING JIM TAYLOR'S INPUT DATA.

2. MODIFY INPUT PARAMETERS BASED ON CB INTERPRETATIONS OF THE GROUNDWATER SYSTEM.
    - A) HORIZONTAL AND VERTICAL TRANSMISSIVITIES
    - B) GRID SPACING
    - C) LAYERING

3. COMPLETE RUNS FOR CB SCENARIOS AND PREPARE REPORT BY DECEMBER, 1984.

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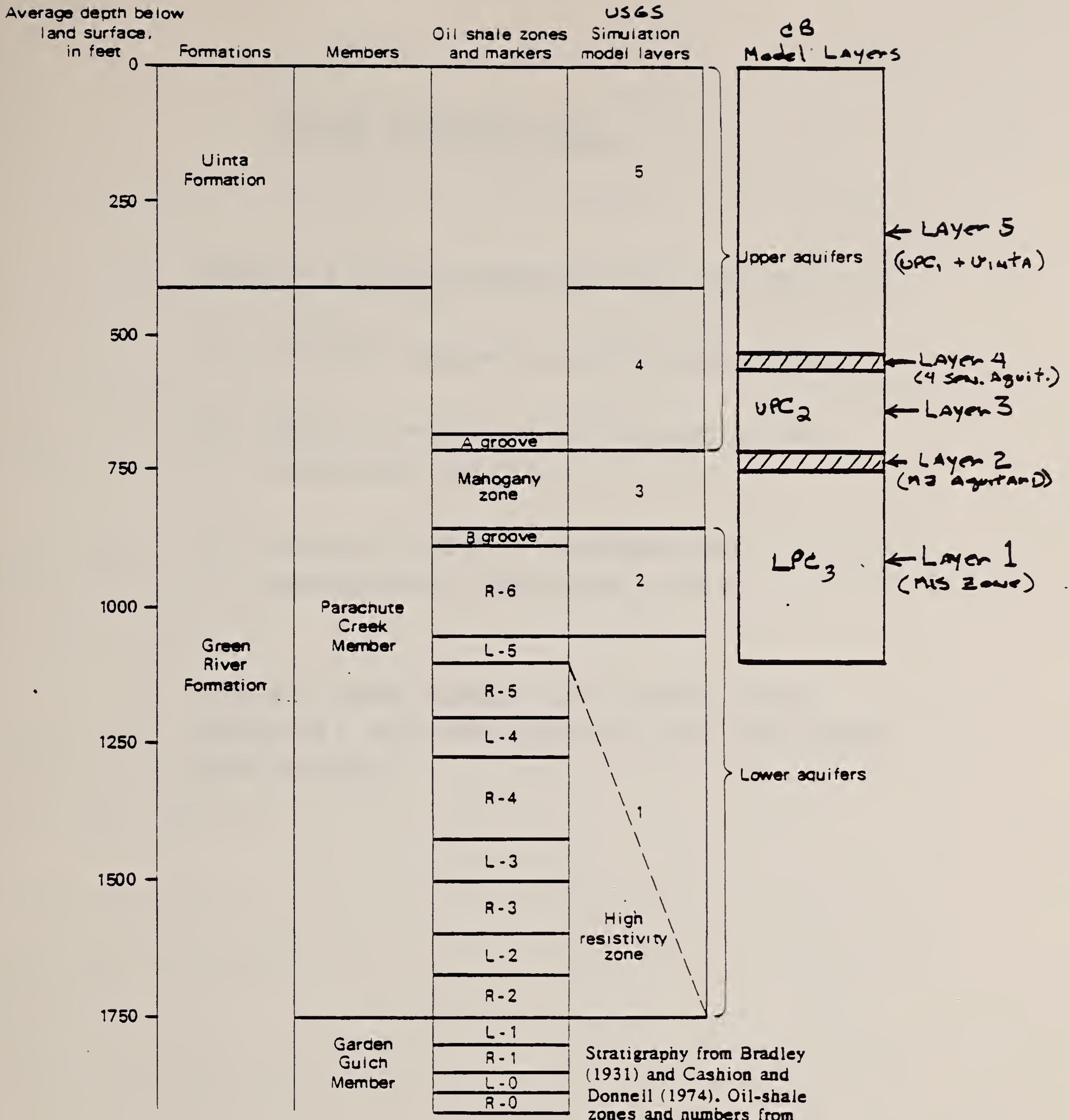

Stratigraphy from Bradley (1931) and Cashion and Donnell (1974). Oil-shale zones and numbers from Cashion and Donnell (1972)

Figure 3.-- Generalized correlation of stratigraphic, oil-shale, and simulation model layers, Piceance basin, northwestern Colorado.

SOLUTE TRANSPORT MODEL

1. DEVELOP A SOLUTE TRANSPORT MODEL FOR CB.

    A) SIMULATE SUBSURFACE CONTAMINANT MOVEMENT.

    B) PREDICT EFFECTS OF MIS RETORTS ON THE GROUNDWATER SYSTEM.

    C) POINT OUT AREAS OF STRENGTHS AND WEAKNESSES OF MONITORING SYSTEM.

2. COMPLETE MODEL RUNS BY JULY, 1985, USING PREVIOUSLY DEVELOPED LEACHING DATA FROM LOGAN WASH RETORTS.

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DEVELOPMENT SCHEDULE

GROUNDWATER MODEL FOR C-B TRACT

ACTIVITY	DATES BEGIN	 END
WRITE WORK SCOPE AND DEVELOP A PLAN FOR MODEL DEVELOPMENT.	04/04/84	05/22/84
OBTAIN USGS MODEL AND INPUTS. DUPLICATE USGS OUTPUTS. DEFINE INPUT PARAMETERS; RE: GRID, LAYERING, PERMEABILITIES, ETC.	05/22/84	06/20/84
DEFINE NEW INPUT PARAMETERS, CHANGE GRID SPACING AT CB AND MAKE NEW RUNS. CALIBRATE MODEL FOR CB AND DOCUMENT.	06/20/84	08/03/84
PREPARE INPUTS FOR VERIFICATION RUNS, CALIBRATE FOR CB WATER LEVELS, DEVELOP PLOTTING ROUTINES FOR DATA AND GENERATE PLOTS.	08/03/84	09/15/84
INTERIM STATUS REPORT	09/15/84	09/30/84
DEVELOP CB SCENARIOS AND EXECUTE MODEL TO PREDICT EFFECTS AT: 1) CB 2) 5-6 MILE RADIUS 3) 10-12 MILE RADIUS 4) PICEANCE BASIN GRID	09/30/84	11/15/84
PREPARE FINAL FLOW MODEL REPORT.	11/15/84	12/30/84
DEVELOP CONVECTIVE-DISPERSIVE TRANSPORT MODEL FOR CB.	01/85	07/85

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3. GROUNDWATER MONITORING PROGRAM

A. CONTINUE MONITORING HYDROLOGIC AND CHEMICAL ASPECTS OF THE CB GROUNDWATER SYSTEM TO SUPPLEMENT AND VERIFY THE FLOW/TRANSPORT MODEL PREDICTIONS.

   1. PRESENT MONITORING PROGRAM.

   2. REVISED MONITORING PLAN BASED ON MODEL PREDICTIONS.

B. POST MIS OPERATIONS MONITORING TO REFINE DATA BASE ON MIS EFFLUENT CHARACTER.

C. VERIFY MODEL PREDICTIONS AND RESULTS.

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II. PRE-IGNITION MIS RETORT WATER MANAGEMENT

- CONTROL WATER AROUND THE MINING ZONE.
- TESTING OF AQUIFER ZONES TO DETERMINE WATER ZONES.
- DETAIL ENGINEERING DESIGN TO HANDLE WATER BEFORE IGNITION.
  - PREVENT INFLOWS
  - DRAIN
- WATER SOURCES
- HORIZONTAL MIGRATION OF WATER.
- VERTICAL MIGRATION OF WATER.

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MIS RETORT ISOLATION FROM GROUNDWATERS

CONTROL OF HORIZONTAL MIGRATION OF GROUNDWATER

1. DRIFTING AROUND RETORTS AND AROUND THE MIS AREA WILL INTERCEPT GROUNDWATERS. ALSO, VERTICAL DRILL HOLES, IF NEEDED, CAN BE USED TO INTERCEPT ANY PROBLEM WATER INFLOWS.

2. ADVANCED DEVELOPMENT OF RETORTS AND DRIFTS WILL AID IN RETORT ISOLATION.

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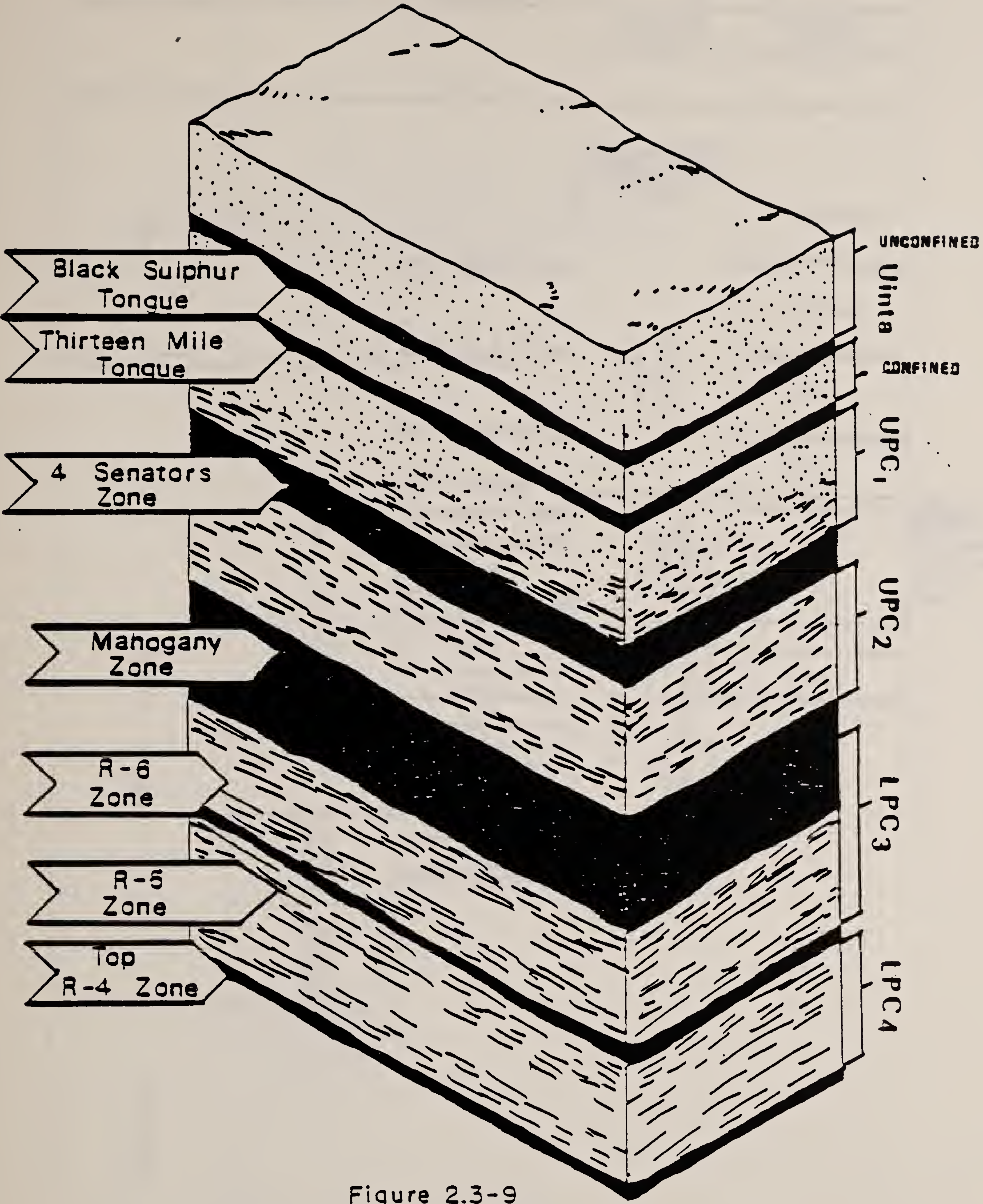
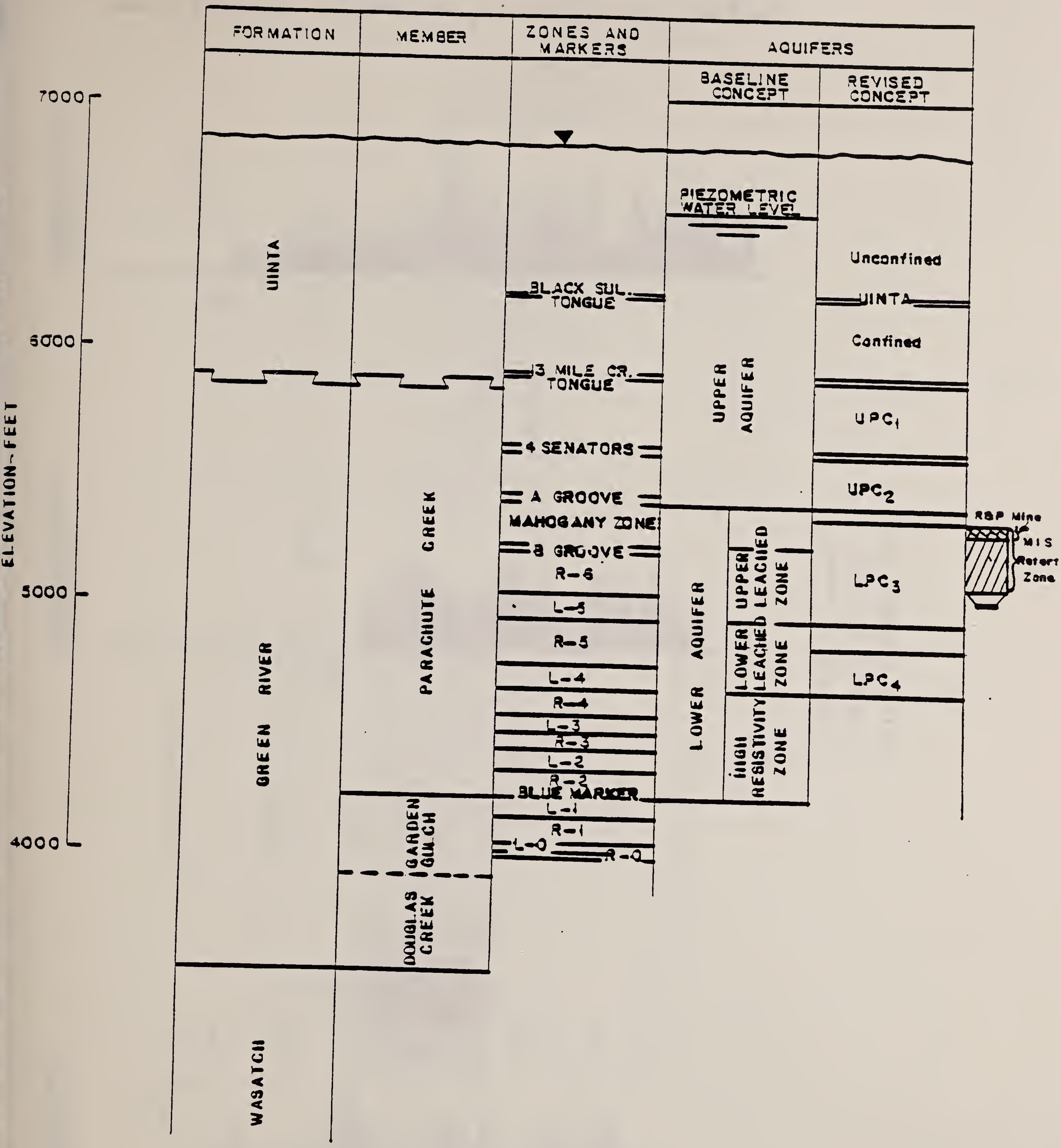


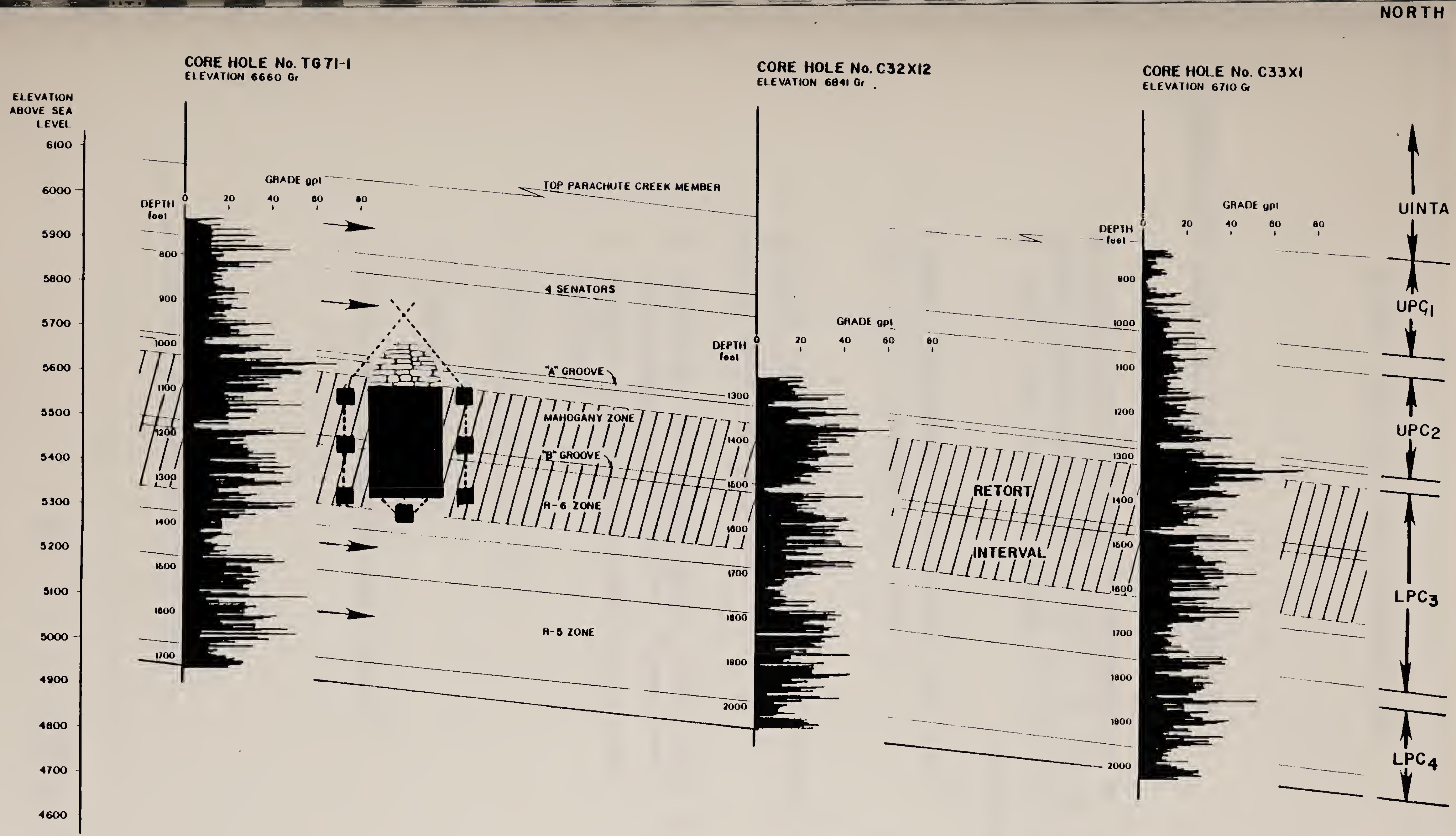
Figure 2.3-9

Subsurface Stratigraphy with

Major Hydrologic Units



STRATIGRAPHIC COLUMN AND AQUIFER CONCEPT



SOUTH TO NORTH
CROSS-SECTION
WITH RETORT ZONE

RETORT ISOLATION FROM GROUNDWATERS

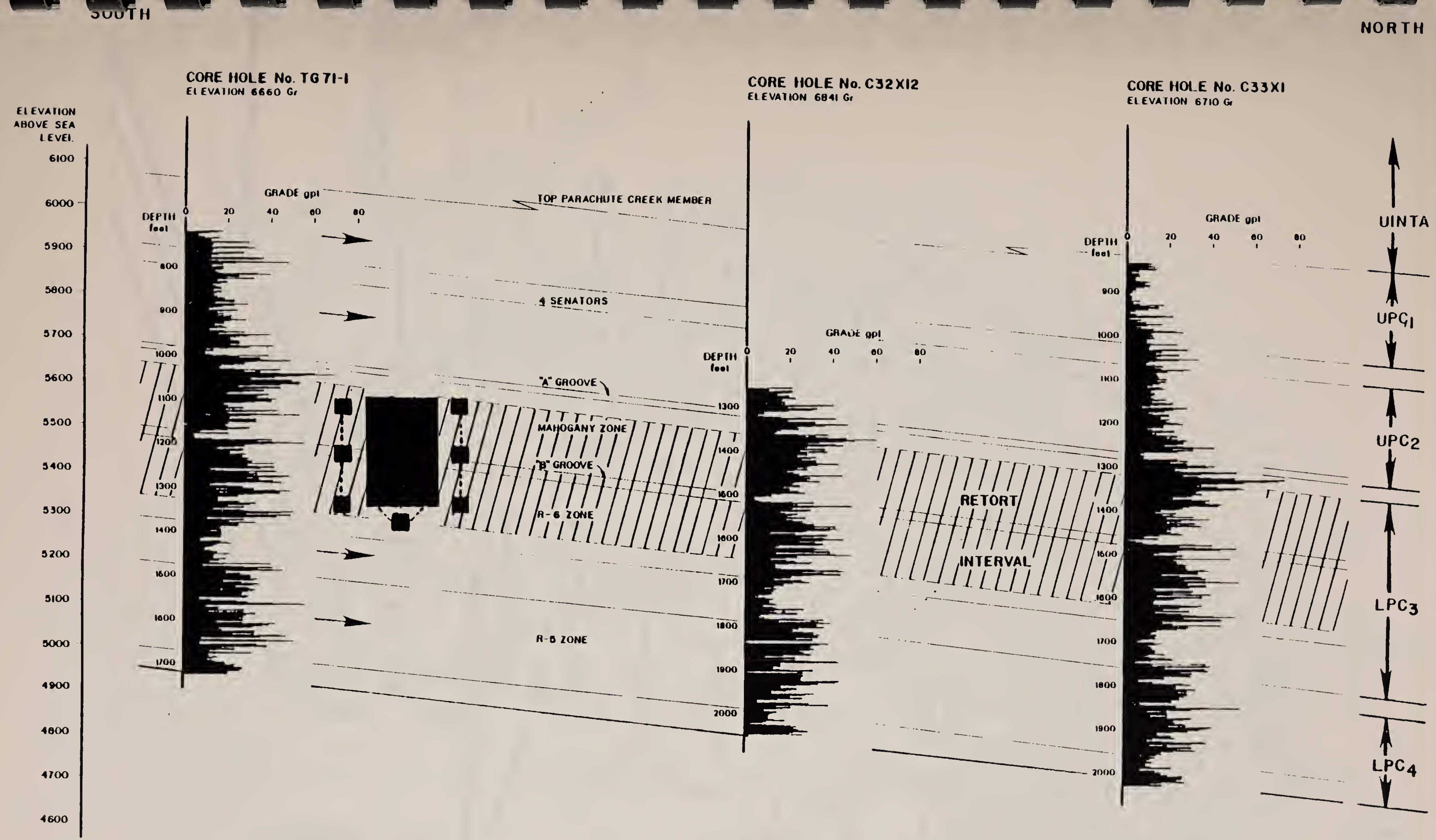
CONTROLLING VERTICAL MIGRATION OF GROUNDWATER

1. DRAINING EXCESS AMOUNTS OF GROUNDWATER IN THE AQUIFER ZONES ABOVE THE A-GROOVE BY USE OF SLANT UP HOLES FROM DRIFTING AROUND THE RETORTS. Least preferred alternative

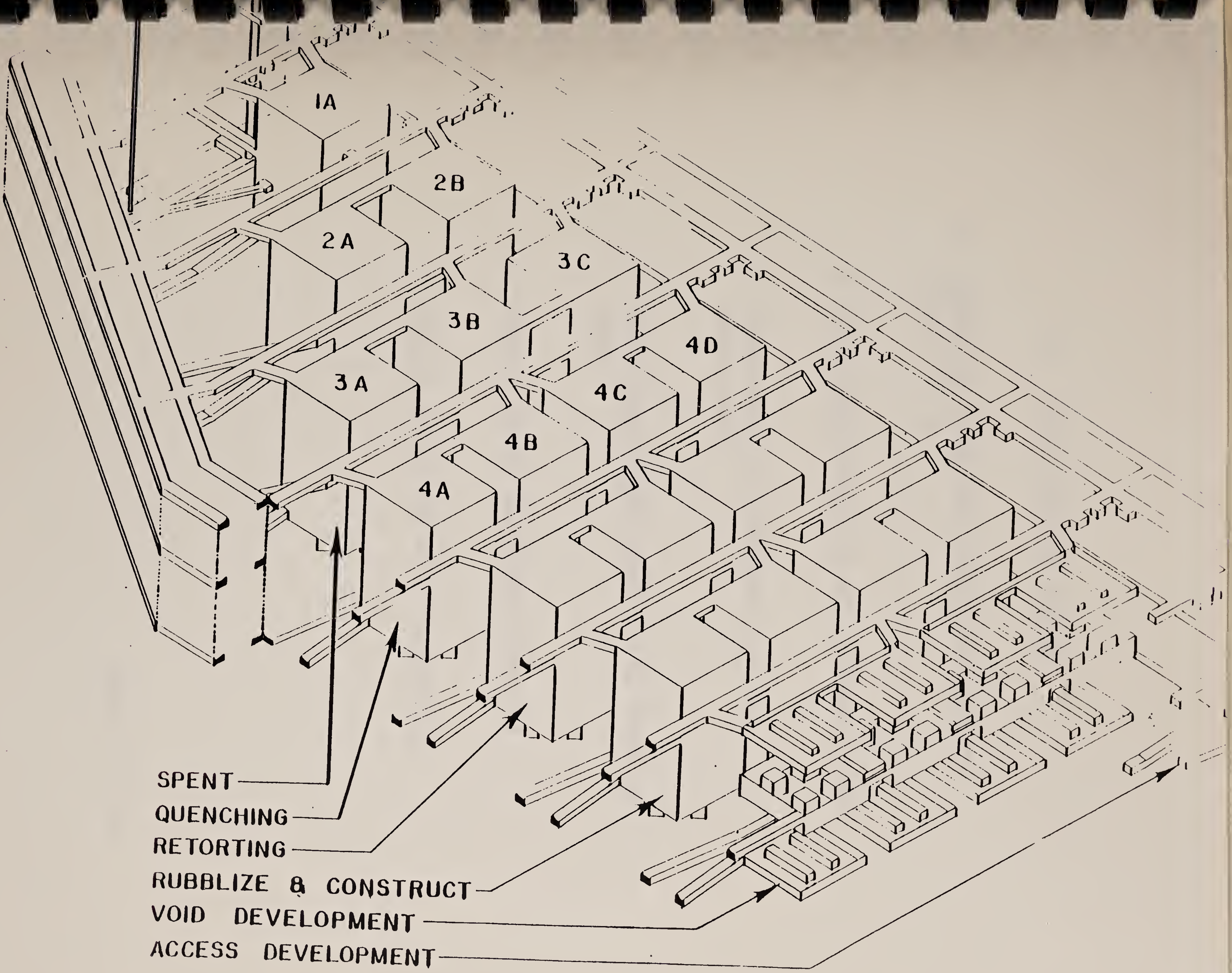
2. ADVANCE DEVELOPMENT OF RETORTS AND DRIFTS WILL AID IN GROUNDWATER CONTROL.

3. OPTIONS AVAILABLE TO MINIMIZE THE POSSIBILITY OF CAVING ABOVE MIS RETORTS.

   - REDUCING THE PLENUM HEIGHT ABOVE EACH RETORT.
     Cb design smaller than Logan Wash 15' to ?
   - REDUCE TIME BETWEEN RUBBLIZATION AND IGNITION.
   - FASTER RETORT IGNITION.
   - SHORTER RETORTS.
   - SUPPLEMENTAL PLENUM ROOF SUPPORT.



SOUTH TO NORTH
CROSS-SECTION
WITH RETORT ZONE


1A
2B
2A
3C
3B
4D
3A
4C
4B
4A
SPENT
QUENCHING
RETORTING
RUBBLIZE & CONSTRUCT
VOID DEVELOPMENT
ACCESS DEVELOPMENT

III. POST-IGNITION TESTING

A. CONTROLLED QUENCHING STUDIES ON FIRST MIS RETORTS AT CB.

- LEACH DATA COLLECTION AND INTERPRETATIONS.
- COMPARISON WITH PREVIOUS DATA AND PREDICTIONS.
- REFINE PRELIMINARY INPUTS IN CB TRANSPORT MODEL.
- PREDICT RETORT ABANDONMENT BEHAVIOR.
- DEVELOP MITIGATION PLAN, IF REQUIRED.

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IV. FINAL ABANDONMENT PLAN

- AT LEAST 35 YEARS OF MONITORING.
- COMPLETE DATA FOR ANALYSIS AND MODELLING.
- PROCESS IMPROVEMENTS

WILL PROVIDE

A COMPLETE, RESPONSIBLE ABANDONMENT PROGRAM FOR MIS RETORTS AND RECLAMATION OF C-B TRACT.

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SUMMARY

SUMMARY - DDP ISSUES

OIL RECOVERY

- INITIAL PLAN DOES NOT COMPROMISE REMAINING RESOURCE
- FUTURE PLANS ARE DESCRIBED WHICH WILL INCREASE LIFE OF PROJECT AND OVERALL OIL RECOVERY
- LESSEE'S FINANCIAL COMMITMENT ONLY TO INITIAL PHASE
- COMMITMENT TO FUTURE PHASES CONTROLLED BY ECONOMICS AND ON-GOING TECHNOLOGY DEVELOPMENT

AGR

- TECHNOLOGY DEVELOPMENT DRIVEN BY ECONOMICS
- GOAL TO PROCESS HIGH GRADE SHALE (40 GPT)
- TEST DISPOSAL PLAN - MINIMIZE ENVIRONMENTAL IMPACTS OF SHALE DISPOSAL
- CO-DISPOSE FINES UNTIL TECHNOLOGY AVAILABLE AND ECONOMICS CAN BE EVALUATED

MIS

- DESIGN CRITERIA AND OPERATIONS - (RESOLVE ANY REMAINING QUESTIONS)
- POST OPERATIONS
  - COLLECT DATA
  - MODEL POTENTIAL POLLUTION DISPERSION
  - ANALYZE DATA/COMPARE WITH PREDICTIONS
  - REFINE MODEL AND MONITORING PLAN
  - ASSESS LONG TERM EFFECTS AND SOLUTIONS
- ABANDONMENT PLAN AND CB TRACT RECLAMATION - TO BE PROVIDED PRIOR TO FINAL ABANDONMENT OF PROJECT

AUG. 1984